WS 2000 Wireless Switch

System Reference

WS 2000 Wireless Switch Version 1.0

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Patents

This product is covered by one or more of the following U.S. and foreign Patents: U.S. Patent No. 4,593,186; 4,603,262; 4,607,156; 4,652,750; 4,673,805; 4,736,095; 4,758,717; 4,760,248; 4,806,742; 4,816,660; 4,845,350; 4,896,026; 4,897,532; 4,923,281; 4,933,538; 4,992,717; 5,015,833; 5,017,765; 5,021,641; 5,029,183; 5,047,617; 5,103,461; 5,113,445; 5,130,520; 5,140,144; 5,142,550; 5,149,950; 5,157,687; 5,168,148; 5,168,149; 5,180,904; 5,216,232; 5,229,591; 5,230,088; 5,235,167; 5,243,655; 5,247,162; 5,250,791; 5,250,792; 5,260,553; 5,262,627; 5,262,628; 5,266,787; 5,278,398; 5,280,162; 5,280,163; 5,280,164; 5,280,498; 5,304,786; 5,304,788; 5,306,900; 5,324,924; 5,337,361; 5,367,151; 5,373,148; 5,378,882; 5,396,053; 5,396,055; 5,399,846; 5,408,081; 5,410,139; 5,410,140; 5,412,198; 5,418,812; 5,420,411; 5,436,440; 5,444,231; 5,449,891; 5,449,893; 5,468,949; 5,471,042; 5,478,998; 5,479,000; 5,479,002; 5,479,441; 5,504,322; 5,519,577; 5,528,621; 5,532,469; 5,543,610; 5,545,889; 5,552,592; 5,557,093; 5,578,810; 5,581,070; 5,589,679; 5,589,680; 5,608,202; 5,612,531; 5,619,028; 5,627,359; 5,637,852; 5,664,229; 5,668,803; 5,675,139; 5,693,929; 5,698,835; 5,705,800; 5,714,746; 5,723,851; 5,734,152; 5,734,153; 5,742,043; 5,745,794; 5,754,587; 5,762,516; 5,763,863; 5,767,500; 5,789,728; 5,789,731; 5,808,287; 5,811,785; 5,811,787; 5,815,811; 5,821,519; 5,821,520; 5,823,812; 5,828,050; 5,848,064; 5,850,078; 5,861,615; 5,874,720; 5,875,415; 5,900,617; 5,902,989; 5,907,146; 5,912,450; 5,914,478; 5,917,173; 5,920,059; 5,923,025; 5,929,420; 5,945,658; 5,945,659; 5,946,194; 5,959,285; 6,002,918; 6,021,947; 6,029,894: 6,031,830; 6,036,098; 6,047,892; 6,050,491; 6,053,413; 6,056,200; 6,065,678; 6,067,297; 6,082,621; 6,084,528; 6,088,482; 6,092,725; 6,101,483; 6,102,293; 6,104,620; 6,114,712; 6,115,678; 6,119,944; 6,123,265; 6,131,814; 6,138,180; 6,142,379; 6,172,478; 6,176,428; 6,178,426; 6,186,400; 6,188,681; 6,209,788; 6,209,789; 6,216,951; 6,220,514; 6,243,447; 6,244,513; 6,247,647; 6,308,061 6,250,551; 6,295,031; 6,308,061; 6,308,892; 6,321,990; 6,328,213; 6,330,244; 6,336,587; 6,340,114; 6,340,115; 6,340,119; 6,348,773; D305,885; D341,584; D344,501; D359,483; D362,453; D363,700; D363,918; D370,478; D383,124; D391,250; D405,077; D406,581; D414,171; D414,172; D418,500; D419,548; D423,468; D424,035; D430,158; D430,159; D431,562; D436,104.

Invention No. 55,358; 62,539; 69,060; 69,187 (Taiwan); No. 1,601,796; 1,907,875; 1,955,269 (Japan); European Patent 367,299; 414,281; 367,300; 367,298; UK 2,072,832; France 81/03938; Italy 1,138,713 (3/02)

Table of Contents

Chapter 1. Overview

WS 2000 Wireless Switch System Reference Guide

This guide is intended to support administrators responsible for understanding, configuring and maintaining the Wireless Switch. This document provides information for the system administrator to use during the initial setup and configuration of the system. It also serves as a reference guide for the administrator to use while updating or maintaining the system.

About this Document

We recommend viewing this online system reference guide with Internet Explorer 5.0 and higher or Netscape Navigator 4.7 or higher on a Microsoft Windows based PC. Viewing this document under other configurations may produce undesirable results.

Document Conventions

Notes

Notes are displayed in blue italic text and indicate a tip or requirement. Warning Warnings are displayed in red italic text and indicate a loss of data or potential injury. GUI Screen text Indicates monitor screen dialog / output from the graphical user interface accessed from any web browser on the network.

Warnings

Warnings are displayed in red italic text and indicate a loss of data or potential injury.

GUI Screen text

Indicates monitor screen dialog / output from the graphical user interface accessed from any web browser on the network.

System Overview

The WS 2000 Wireless Switch provides a low-cost, feature-rich wireless switch for sites with one to six Access Ports. The WS 2000 Wireless Switch works at the center of a network's infrastructure to seamlessly and securely combine wireless LANs (WLANs) and wired networks. The switch sits on the network. Wireless Access Ports connect to one of the six available ports on the switch and the external wired network (WAN) connects to a single 10/100 Mbit/sec. WAN port.

Mobile units (MUs) associate with the switch via an Access Port. Once an MU contacts the switch, the switch cell controller services attempt to authenticate the device for access to the network.

The WS 2000 Wireless Switch acts as a WAN/LAN gateway and a wired/wireless switch.

Management of Access Ports

This wireless switch provides six 10/100 Mbit/sec. LAN ports for internal wired or wireless traffic. Four of these ports provide IEEE 802.3af-compliant Power over Ethernet (PoE) support for devices that require power from the Ethernet connection (such as Access Ports). Administrators can configure the six ports to communicate with a private LAN or with an Access Port for a wireless LAN (WLAN). The switch provides three extended service set identifiers (ESSIDs) for each Access Port connected to the switch.

Firewall Security

The LAN and Access Ports are placed behind a user configurable firewall that provides stateful packet inspection. The wireless switch performs network address translation (NAT) on packets passing to and from the WAN port. This combination provides enhanced security by monitoring communication with the wired network.

Wireless LAN (WLAN) Security

Administrators can configure security settings independently for each ESSID. Security settings and protocols available with this switch include:

- Kerberos
- WEP-40
- WEP-128
- 802.1x with RADIUS
- 802.1x with Shared Key
- KeyGuard-MCM
- WPA

Hardware Overview

The WS 2000 Wireless Switch provides a fully integrated solution for managing every aspect of connecting wireless LANs (WLANs) to a wired network. This wireless switch can connect directly to a cable or DSL modem, and can also connect to other wide area networks through a Layer 2/3 device (such as a switch or router). It includes the following features:

- One WAN (RJ-45) port for connection to a DSL modem, cable modem, or any other Layer 2/3 network device.
- Six 10/100 Mbit/sec. LAN (RJ-45) ports: four ports provide 802.3af “Power over Ethernet” (PoE) support; the other two do not provide power.
- Each port has two LEDs, one indicating the speed of the transmission (10 or 100 Mbit/sec.), the other indicating whether there is activity on the port. The four LAN ports with PoE have a third LED that indicates whether power is being delivered over the line to a power device (such as an Access Port). (See the WS 2000 Wireless Switch LED explanation for more information on the meaning of the different state of the LEDs.)
- A DB-9 serial port for direct access to the command-line interface from a PC. Use Symbol’s Null-Modem cable (Part No. 25-632878-0) for the best fitting connection.
- A CompactFlash slot that provides AirBeam™ support.

Technical Specifications

Physical Specifications

- Width: 203 mm
- Height: 38 mm
- Depth: 286 mm
- Weight: 0.64 kg

Power Specifications

- Maximum Power Consumption: 90-256 VAC, 47-63 Hz, 3A
- Operating Voltage: 48 VDC
- Operating Current: 1A
- Peak Current: 1.6A

Environmental Specifications

- Operating Temperature: 0ºC to 40ºC
- Storage Temperature: -40ºC to 70ºC
- Operating Humidity: 10% to 85% Non-condensing
- Storage Humidity: 10% to 85% Non-condensing
- Operating Altitude: 2.4 km
- Storage Altitude: 4.6 km

Software Overview

The WS 2000 Wireless Switch software provides a fully integrated solution for managing every aspect of connecting Wireless LANs (WLANs) to a wired network, and includes the following components:

Operating System (OS) Services

OS Services determine how the WS 2000 Wireless Switch communicates with existing network and operating system-centric software services, including:

- Dynamic Host Configuration Protocol (DHCP)
- Telnet and File Transfer Protocol (FTP/TFTP) servers
- The Simple Network Time Protocol (SNTP) client, used to keep switch time synchronized for Kerberos authentication

Cell Controller Services

The Cell Controller provides the ongoing communication between mobile units (MUs) on the Wireless LAN (WLAN) and the wired network. Cell Controller services perform the following:

- Initialize the Access Ports
- Maintain contact with Access Ports by sending a synchronized electronic “heartbeat” at regular intervals
- Track MUs when they roam from one location to another
- Manage security schemes based on system configuration
- Maintain system statistics
- Store policies and Access Port information

Gateway Services

Gateway services provide interconnectivity between the Cell Controller and the wired network, and include the following:

- System management through a web-based Graphical User Interface (GUI) and SNMP
- 802.1x RADIUS client
- Security, including Secure Sockets Layer (SSL) and Firewall
- Network Address Translation (NAT), DHCP services, and Layer 3 Routing

Chapter 2. Features

802.11a Support

802.11 is a family of specifications for wireless local area networks (WLANs) developed by a working group of the Institute of Electrical and Electronics Engineers (IEEE). The four current specifications include: 802.11, 802.11a, 802.11b, and 802.11g. All four use the Ethernet protocol and carrier sense multiple access with collision avoidance (CSMA/CA) for path sharing, which allows a number of network users to pass packets on the network simultaneously.

The 802.11a specification applies to wireless systems, and is used in access hubs and other network components. 802.11a operates at radio frequencies between 5 GHz and 6 GHz, using a modulation scheme that provides for data speeds of 6, 9, 12, 18, 22, 24, 36, 48, and 54 Mbps.

The WS 2000 Wireless Switch fully supports the 802.11a specification for association with Symbol's suite of compatible Access Ports and mobile units (MUs).

Specifically, the WS 2000 Wireless Switch supports the following features:

- **Management frames**: Part of a network packet, management frames provide hardware- and software-specific information shared between the WS 2000 Wireless Switch, Access Ports, and MUs to keep the network operating smoothly.
- **Beacon and DTIM**: A uniframe (single-direction) system packet broadcast by the WS 2000 Wireless Switch to keep the network synchronized. A beacon Includes the Net_ID (ESSID), the Access Port address, the broadcast destination addresses, a time stamp, a DTIM (Delivery Traffic Indicator Maps) and the TIM (Traffic Indicator Message)
- **Roaming Updates**: Provides information to the Access Ports when an MU roams from one Access Port to another
- **Power Save Polling (PSP)**: Helps extend battery life by allowing the radio in an Access Port or MU to idle when not active.
- **Voice Prioritization**: The WS 2000 Wireless Switch uses a combination of data classifiers, classification groups, and network input and output policies to prioritize voice data.
- **Rate Scaling**: This feature seeks to connect MUs to the WS 2000 Wireless Switch (via Access Port) at the highest possible rate, automatically scaling to a lower rate when network traffic demands. As signal clarity increases, speed builds to an optimal rate.
- **TX power setting**: Optimizes the output power for any environment.

802.11b Support

802.11 is a family of specifications for wireless local area networks (WLANs) developed by a working group of the Institute of Electrical and Electronics Engineers (IEEE). The four current specifications include: 802.11, 802.11a, 802.11b, and 802.11g. All four use the Ethernet protocol and provide carrier sense multiple access with collision avoidance (CSMA/CA) for path sharing, which allows a number of network users to pass packets on the network simultaneously.

The 802.11b standard, also called Wi-Fi (Wireless Fidelity), is backward compatible with 802.11. 802.11b uses complimentary code keying (CCK) modulation to provide higher data speeds (up to 11 Mbps) with less multipath-propagation interference. 802.11b operates at the 2.4 to 2.5 GHz range.

The WS 2000 Wireless Switch fully supports the 802.11b specification for association with Symbol's suite of compatible Access Ports and mobile units (MUs).

Specifically, the WS 2000 Wireless Switch supports the following features:

- **Management frames**: Part of a network packet, management frames provide hardware- and software-specific information shared between the WS 2000 Wireless Switch, Access Ports, and MUs to keep the network operating smoothly.
- **Beacon and DTIM**: A uniframe (single-direction) system packet broadcast by the WS 2000 Wireless Switch to keep the network synchronized. A beacon Includes the Net_ID (ESSID), the Access Port address, the Broadcast destination addresses, a time stamp, a DTIM (Delivery Traffic Indicator Maps) and the TIM (Traffic Indicator Message).
- **Roaming Updates**: Provides information to the Access Ports when an MU roams from one Access Port to another.
- **Power Save Polling (PSP)**: Helps extend battery life by allowing the radio in an Access Port or MU to idle when not active.
- **Voice Prioritization**: The WS 2000 Wireless Switch uses a combination of data classifiers, classification groups, and network input and output policies to prioritize voice data.
- **Rate Scaling**: This feature seeks to connect MUs to the WS 2000 Wireless Switch (via Access Port) at the highest possible rate, automatically scaling to a lower rate when network traffic demands. As signal clarity increases, speed builds to an optimal rate.
- **TX power setting**: Optimizes the output power for any environment.

Access Ports

Access Ports are the Symbol devices that pick up wireless transmissions and translate them into Ethernet frames that are sent to the wireless switch for processing and routing. The packets destined for wireless networks are sent back to the Access Ports where they are transmitted.

Access Ports may be connected directly to the WS 2000 Wireless Switch or through a PoE (Power over Ethernet) hub connected to the WS 2000. Up to six Access Ports can be connected to this wireless switch.

When an Access Port is attached to a switch, it sends out a "boot me" packet as a broadcast message. This packet specifies the hardware model of the port and its MAC address. When the WS 2000 Wireless Switch receives a "boot me" packet, it uploads the appropriate firmware for the Access Port. Once complete, the Access Port becomes active.

For an Access Port to be adopted by the WS 2000 Wireless Switch, three things must be configured:

1. The Country field in the System Settings screen must be set.
2. The Access Port's MAC address must be set as one of the addresses that can be adopted by one of the enabled WLANs. (see Step 4)
3. A WLAN that can adopt Access Port must be associated with an enabled subnet. (see Step 5)

Gateway Services

Network Address Translation (NAT)

NAT provides the translation of an Internet Protocol (IP) address within one network to a different, known IP address within another network. One network is designated the private network, while the other is the public. NAT provides a layer of security by translating local, private network addresses to one or more global, public IP addresses through a corporate firewall. The translation process provides an opportunity to authenticate outgoing or incoming requests or match these requests to a previous request. NAT allows a company to use a single IP address to communicate with the Internet community.

The WS 2000 Wireless Switch provides service, or forward, and reverse NAT translation on packets to and from the WAN and is fully compliant with RFC 1631.

WS 2000 Wireless provides network administrators with the following implementation options:

- Mapping up to 8 public IP addresses to private IP address ranges.
- Client IP addresses on the private side have IP addresses translated to ports or IP addresses on the WAN. Administrators can configure connections to originate from either end.
    - One-to-one mapping with a private IP address or a range of private IP addresses.
- Private side IP address can belong to any of the private side subnets.
    - Ranges can be specified from each of the private side subnets.

WS 2000 Wireless Switch Firewall

The firewall includes a proprietary CyberDefense Engine to protect internal networks from known Internet attacks, including FTP Bounce, MIME Flood, IP Spoofing, Land Attack, Ping of Death, Reassembly, SYN Flooding, and Winnuke. It also provides additional protection by performing the following checks: source routing, IP unaligned timestamp, and sequence number prediction.

Firewall features include:

Stateful Inspection Engine

The firewall inspects incoming packets based on security policies before processing them in higher-level protocols. This feature significantly boosts performance, as packets do not require copying from the operating system to user space for inspection.

Access Policies

Access policies define how network services, including source and destination IP addresses, range or subnet IP address, ports, and access time windows, work. Administrators organize the user community in different user groups and define access policies on per user group basis.

Administration Management

Administrators change access policies locally or remotely, using the web-based user interface (UI) or by modifying text-based configuration files.

DHCP Client and Server

The WS 2000 Wireless Switch can act as a DHCP client on the WAN and each of its three subnets. It also act as an independent DHCP server on each of the three subnets.

Layer 3 Routing

Overview

The WS 2000 Wireless Switch provides Layer 3 routing support to the Network Address Translation (NAT) and Firewall modules. Layer 3 refers to a network layer that selects routes and quality of service based on knowing the address of the neighboring nodes in the network. This routing provides recognition and forwards incoming messages to the Transport layer for local host domains.

Routing Information Protocol (RIP) Support

Layer 3 supports RIP, a widely used protocol for managing router information within a self-contained network or a group of networked LANs.

Using RIP, the WS 2000 Wireless Switch sends a routing table with information containing all the hosts it is configured to identify to the closest LAN host. The LAN host passes the information on to the next closest LAN host until all hosts within the network have the same knowledge of routing paths, a condition referred to as network convergence. Network components distribute routing table information at preset intervals to maintain convergence. To route a packet to a specified destination, each host with a router in the network uses the routing table information to determine the destination host location.

SNMP Management Support

Simple Network Management Protocol (SNMP) is the protocol governing network management and the monitoring of network devices and their functions. SNMP defines the method for obtaining information about network operating characteristics and lets administrators change parameters for routers and gateways.

SNMP uses the Management Information Base (MIB), or formal description of a set of network objects that represent the switch components, to facilitate network management in any wireless network environment.

SNMP management features include:

- Allowing gets, or the ability to retrieve data from a remote host given its host name and authentication information
- Allowing sets, or the ability to modify information on a remote host
- A web-based user interface (UI) for viewing traps, which network entities use to signal abnormal conditions to management stations. Administrators define trap conditions in the MIB.

The WS 2000 Wireless Switch provides management support for SNMP versions 1, 2, and 3.

WEP 64 (40-bit key)

Wired Equivalency Privacy (WEP) uses a key, or string of case-sensitive characters, to encrypt and decrypt data packets transmitted between a mobile unit (MU) and the WS 2000 Wireless Switch. The administrator configures mobile units (MUs) and the WS 2000 Wireless Switch to use the same key.

WEP encrypts the wireless transmissions, but still allows communication among compatible wireless LAN clients and MUs from third-party manufacturers that are 802.11b certified.

40-bit Shared Key requires encryption be set up in one of the following ways:

- **String**: For use only with other Symbol Technologies wireless LAN devices, an encryption string is a case-sensitive string of characters between 6 and 30 characters long.
- **Shared keys**: Hexadecimal keys are sequences of hexadecimal digits arranged into four keys. A hexadecimal digit could be a letter from A to F or a number from 0 to 9. This type of encryption is compatible with equipment from other manufacturers that use Wi-Fi certified 40-bit encryption.

WEP 128 (104-bit Key)

Wired Equivalency Privacy (WEP) uses a key, or string of case-sensitive characters, to encrypt and decrypt data packets transmitted between a mobile unit (MU) and the WS 2000 Wireless Switch. The administrator configures the MU and switch to use the same key. 104-bit Shared Key provides a higher level of security than the 40-bit Shared Key option and uses a more complicated encryption scheme.

WEP encrypts the wireless transmissions, but still allows communication among compatible wireless LAN clients and MUs from third-party manufacturers that are 802.11b certified.

WEP 128 requires encryption be set up in one of the following ways:

- **String**: For use only with other Symbol Technologies wireless LAN devices, an encryption string is a case-sensitive string of characters between 6 and 30 characters long.
- **Shared keys**: Hexadecimal keys are sequences of hexadecimal digits arranged into four keys. A hexadecimal digit could be a letter from A to F or a number from 0 to 9.

802.1x with RADIUS Authentication

RADIUS is a client/server protocol and software that enables remote access servers to communicate with a central server to authenticate RADIUS-enabled mobile units (MUs) and authorize their access to the requested system or service.

When an MU authenticates with a WS 2000 Wireless Switch through an Access Port, the switch initially performs RADIUS authentication, even though the RADIUS server exists as a separate entity on the wired LAN. This RADIUS server maintains user profiles in a central database that all remote servers can share. This centralized location provides better security by using a policy-based implementation through a single administered network point.

The RADIUS server on the wired LAN communicates with the WS 2000 Wireless Switch RADIUS client, passing authentication information from the MU. A successful negotiation authenticates the MU.

The pair-wise master keys (PMK) generated by this negotiation are used to generate keys used in MAC encryption. In the absence of a RADIUS server, 802.1x is used in a pre-shared key configuration. Administrators configure the master key statically through the configuration or the key is obtained through negotiation from an external RADIUS server in compliance with 802.1x.

The WS 2000 Wireless Switch uses the Remote Authentication Dial-In User Service (RADIUS) to authenticate 802.1x-enabled MUs.

802.1x with Shared Key Authentication

Shared key authentication, part of the Wired Equivalency Privacy (WEP) algorithm, provides a basic means of data encryption to improve data security for a Wireless LAN (WLAN). The shared key algorithm performs data encryption and decryption. A wireless device with a valid shared key is allowed to associate with the WS 2000 Wireless Switch and access services on the wired LAN.

Using shared key authentication, an administrator configures mobile units (MUs) and the WS 2000 Wireless Switch to share the same key. The MU authenticates by presenting the key to a WS 2000 Wireless Switch. The switch examines the key, and uses it to perform a checksum, or error-checking operation, by comparing the key to one on the switch. The MU accesses network services only when the key passes the checksum process.

The WS 2000 Wireless Switch uses shared key authentication when there is no RADIUS server on the wired LAN.

Kerberos Authentication

The Kerberos authentication service protocol (specified in RFC 1510) provides a secure means for authenticating users/clients in a wireless network environment.

With Kerberos, a client (generally either a user, a service, or a user requesting any number of network services) within the Kerberos Realm sends a request for a ticket to the Key Distribution Center (KDC). The KDC creates a ticket-granting ticket (TGT) for the client, encrypts it using the Ticket Granting Server's (TGS) secret key, and sends the encrypted TGT back to the client. In addition to the TGT, the KDC simultaneously sends a session key (SK1) encrypted with the client's password to the client. The client then attempts to decrypt the session key using its password. If the client successfully decrypts the session key (i.e., if the client gave the correct password), it keeps the decrypted session key, which indicates proof of the client's identity. The TGT permits the client to obtain additional tickets (TK-TS) which give permission for specific network services (any application or service) for the allotted time identified in the TK-TS. The requesting and granting of these additional tickets is user-transparent. Once the session tickets expire, the client must re-authenticate to continue using network services.

The KDC operates in a Master or a Slave capacity. The Master KDC maintains the master database file that contains all of the user authentication information. This information includes the user's name, password, and authorization level. This authorization level determines what network services the user has access to.

The Slave KDC acts in a backup capacity to the Master KDC. Database information propagates from the Master KDC to the Slave at regular intervals. If the Master KDC fails, the Slave KDC resumes ticket granting services until the problem causing the Master KDC to fail is resolved. The Slave KDC has no database administration privileges, which are reserved for the Master KDC.

When a Kerberos-enabled mobile unit (MU) authenticates with WS 2000 Wireless through an Access Port, the switch initially performs Kerberos authentication, even though the Kerberos server exists as a separate entity on the wired LAN. On initial request from a Kerberos-enabled MU, the WS 2000 Wireless Switch acts as a proxy to the external KDC. The switch passes initial Kerberos authentication information to the external KDC until the MU authenticates in the manner described in this section. Once authenticated, the user maintains access to the wired network for the allotted time provided by the session ticket (TK-TS).

Once an administrator enables Kerberos on a device, the device must pass authentication before wireless access via the device is permitted to the wired LAN.

KeyGuard-MCM Support

KeyGuard-MCM (Mobile Computing Mode) is Symbol Technologies' security enhancement algorithm based on the Temporal Key Integrity Protocol (TKIP) from the forthcoming IEEE 802.11i standard. KeyGuard-MCM provides an enhanced solution for protecting data transfer over a Wireless LAN (WLAN) by using a proprietary algorithm to encrypt, decrypt, and transmit network packets.

KeyGuard-MCM leverages existing WEP encryption hardware by providing per-packet key mixing, a message integrity check, and a re-keying mechanism, which changes the security key set by the administrator when KeyGuard-MCM recognizes a potential compromise of network security.

KeyGuard-MCM works with all Symbol Technologies' mobile units that support 128-bit WEP. KeyGuard-MCM is fully compatible with other network security protocols, including RADIUS and Kerberos.

The WS 2000 Wireless Switch fully supports KeyGuard-MCM.

Wireless Protected Access (WPA)

WEP uses a key, or string of case-sensitive characters, to encrypt and decrypt data packets transmitted between a mobile unit (MU) and the WS 2000 Wireless Switch. The administrator configures mobile units (MUs) and the WS 2000 Wireless Switch to use the same key.

WPA specifies the use of the TKIP, and optionally, 802.1x for encryption.

Chapter 3. Getting Started

Getting Started Overview

Installing the Switch

To install the WS 2000 Wireless Switch hardware, follow the directions in the *WS 2000 Wireless Switch Quick Installation Guide* found in the box with the switch and on the CD-ROM that is distributed with the switch. These instructions describe how to:

- Select a site (desk, wall, or rack) for the switch
- Install the switch using the appropriate accessories for the selected location
- Connect devices to WAN and LAN ports (using standard CAT5 cables)
- Interpret the port LEDs on the front of the switch

Note: Access Ports must be connected to the LAN ports of the wireless switch to enable configuration of the Access Port related settings.

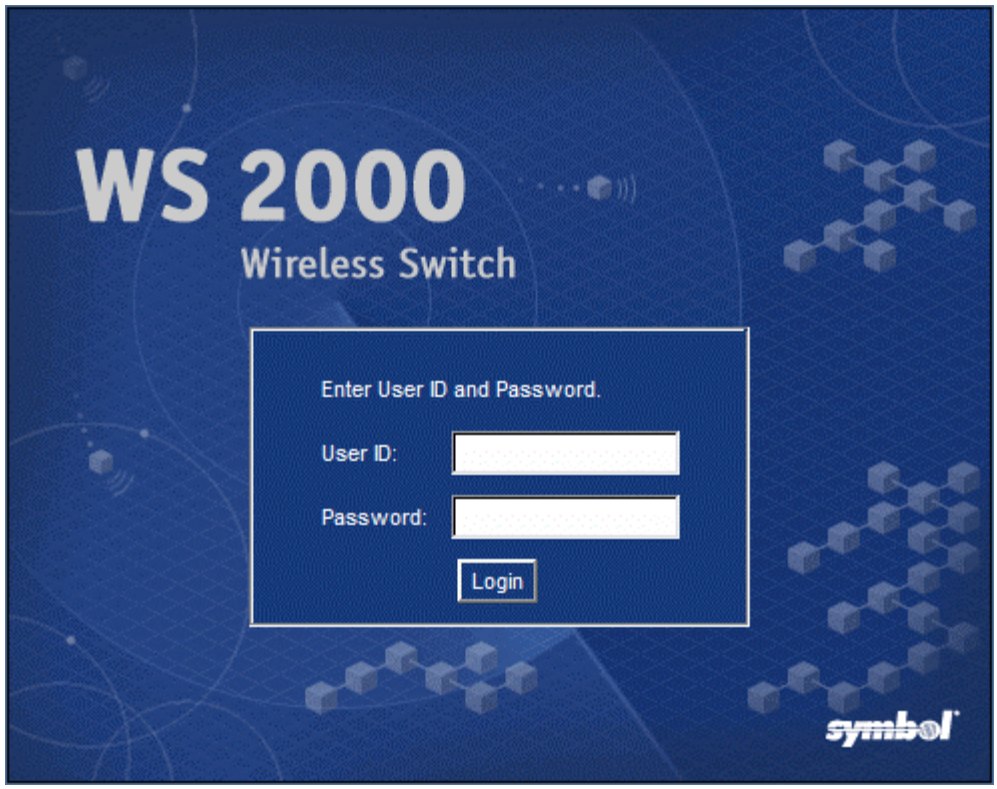
Set up Communication to the Switch

Before the configuration process can begin, a link with the wireless switch needs to be established:

1. Connect a computer to the switch (in any one of the LAN ports) using a standard CAT5 cable.
2. Set up the computer for TCP/IP DHCP network addressing.
3. Start up Internet Explorer (with Microsoft's Java Virtual Machine installed) and type in the following IP address in the address field: 192.168.0.1

   Note: For optimum compatibility use Microsoft's Java Virtual Machine, and be sure to disable the Sun Microsystems' JRE. If Microsoft's Java Virtual Machine is unavailable, please use Sun Microsystems' JRE version 1.3 for best.

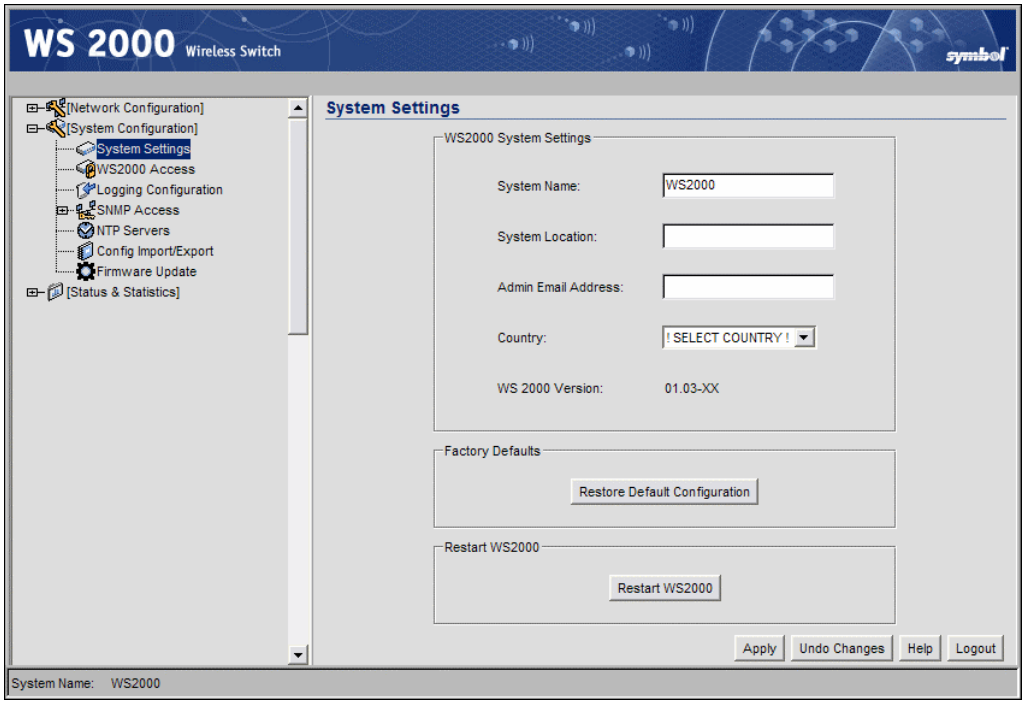
   The following screen is displayed.



4. Log in using "**admin**" as the username and "**symbol**" as the password.
5. If the login is successful, the following prompt will be displayed.

   Enter a new admin password in both fields, and click the **Update Password Now** button.

6. Once the admin password has been updated, the System Settings screen is displayed.



7. Enter a **System Name** for the wireless switch. The specified name appears in the lower-left corner of the configuration screens, beneath the navigation tree. This name can be a useful reminder if multiple Symbol wireless switches are installed.
8. Enter a text description of the location of the switch in the **System Location** field. This text is used as a reminder to the network administrator and is also used to set the location variable if the switch is administered using SNMP.
9. Enter an email address for the administrator in the **Admin Email Address** field. The switch will use this address for sending SNMP-related and other administration-related messages to the administrator.
10. Select the **Country** for the switch from the drop-down menu. Selecting the correct country is extremely important. Each country has its own regulatory restrictions concerning electromagnetic emissions and the maximum RF signal strength that can be transmitted by Access Ports. To ensure compliance with national and local laws, be sure to set this field accurately.
11. Click **Apply** to save changes. Unapplied changes are lost if the administrator navigates to a different screen.

Changing the Administrator Password

The password information set at the factory is the same for all WS 2000 Network Switches. For security reasons, it is important to change the switch's admin password as soon as possible.

1. Select **System Configuration** --> **WS-2000 Access** from the left menu.
2. Click the **Change Admin Password** button. A sub-screen will appear.
3. Enter the current admin password ("symbol" if it hasn't been changed previously), as well as a new password (limited to 11 characters in length). Enter the new password a second time in the field provided.
4. Click **Update Password Now** to set the new password.

Configuring the Switch

Once the switch is installed, perform the rest of the basic configuration and setup process as indicated in the following procedures. The links go to pages that have detailed information about the particular configuration step. The left menu item associated with each procedure is specified to the right of the link

- Step 1: Configure the LAN interface and enable subnets (**Network Configuration** --> **LAN** in the left menu)·
- Step 2: Configure subnets (**Network Configuration** --> **LAN** --> **Subnet**)
- Step 3: Configure the WAN Interface (**Network Configuration** --> **WAN**)
- Step 4: Enable Wireless LANs (WLANs) (**Network Configuration** --> **Wireless**)
- Step 5: Configure WLANs (**Network Configuration** --> <WLAN name>)
- Step 6: Configure WLAN Security (**Network Configuration** --> <WLAN name> --> **Security**)
- Step 7: Configure Access Ports (**Network Configuration** --> **Access Ports** --> <Access Port Name>)
- Step 8: Configure subnet access (**Network Configuration** --> **Subnet Access**)

The following advanced setup tasks are optional:

- Set up the firewall configuration (**Network Configuration** --> **WAN** --> **Firewall**)
- Set up Network Address Translation (NAT) (**Network Configuration** --> **WAN** --> **NAT**)
- Set up static routing (**Network Configuration** --> **Router**) Refer to the two case studies provided with this reference for specific installation examples.

These case studies describe the environment, the desired features, and the configuration selections that were made in two different scenarios.

- Case 1: Small Retail Store (with handheld terminals, wireless printers, wired POS, secured access to in-store server, and public access to WAN)·
- Case 2: Small Branch Office (with 3 WAN IP addresses, VPN passthrough, RADIUS server, and full-access between subnets)

Proceed to: Step 1: Configure the LAN Interface

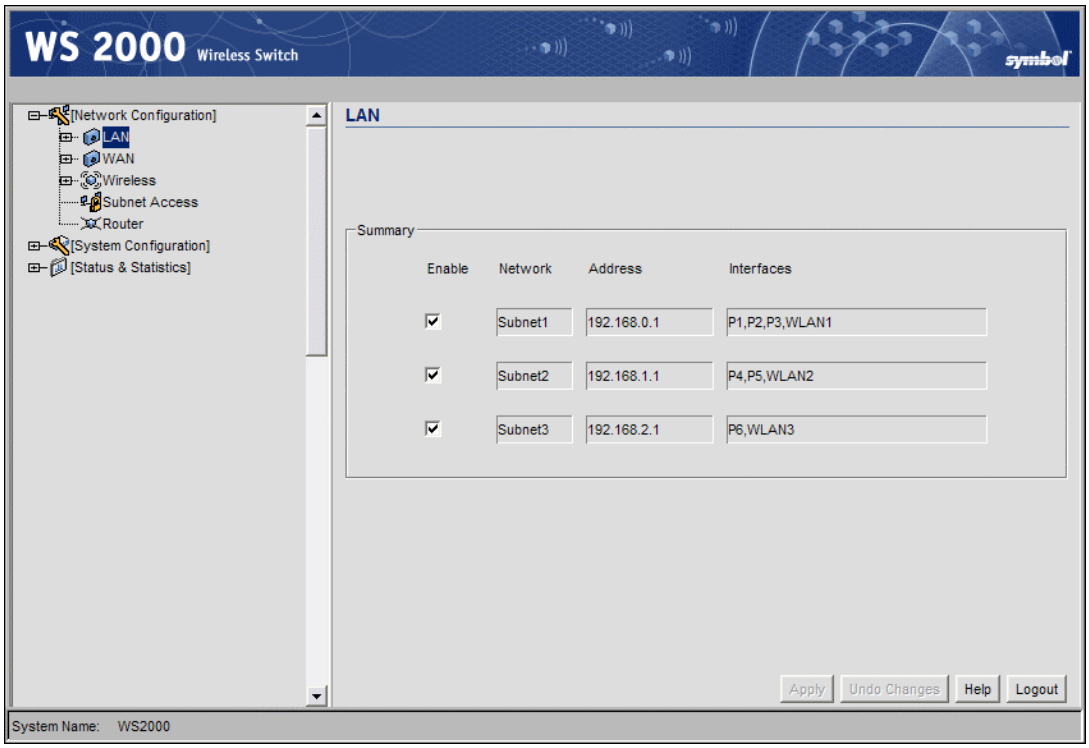
Step 1: Configure the LAN Interface

The first step of the network configuration process is to figure out the topology of the LAN. The WS 2000 Wireless Switch allows the administrator to enable and configure three different subnets. The administrator can assign a IP address, port associations, DHCP settings, and security settings to each subnet.

This System Reference provides two case studies that demonstrate how requirements for network access and capabilities drive the decisions of how to configure the subnets.

Defining the Subnets

Select **LAN** under the **Network Configuration** group from the left menu. Use the LAN configuration screen to view a summary of physical-port addresses and Wireless LANs (WLANs) associated with the three supported subnets, and to enable or disable each configured subnet.



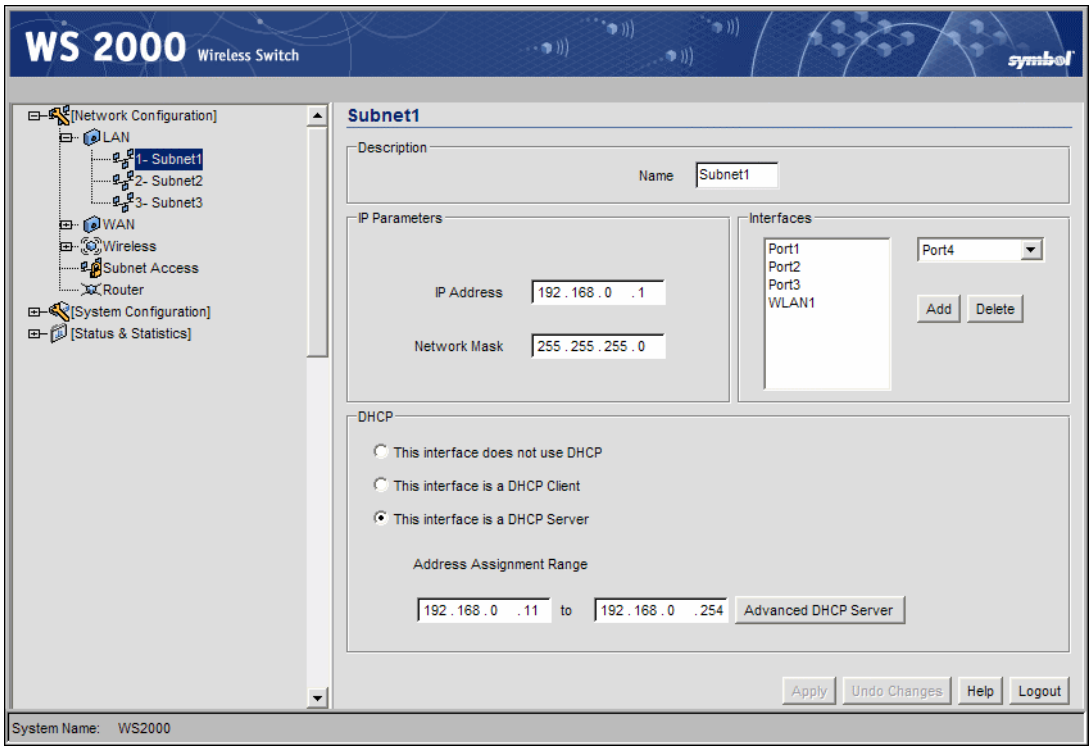
1. In the **LAN** screen, the administrator can enable one, two or three subnets. Check the checkbox to the left of the subnet to enable a subnet. Up to three subnets can be enabled to use the wired and/or wireless connections of the switch-managed LAN. Enable multiple subnets to divide the communications of different business areas or operations. Each enabled subnet shows up in the directory tree in the left column of the configuration screens. Consider disabling a previously configured subnet if its assigned ports are no longer in use, or to consolidate the LAN's communications on fewer subnets.
2. Click **Apply** to save changes—all "unapplied" changes are lost when the administrator moves to a new screen. The rest of the information on this screen is summary information— it is collected from other screens (such as the subnet configuration screens) where the administrator can set the data.

Field	Description
Network	**Network** (subnet) name is a descriptive string that should describe the subnet's function. The WS 2000 Network Management System uses subnet names throughout the configurations screens.
Address	This IP address allows users from outside the subnet (whether from the WAN or from another subnet from the same switch) to access the right subnet. An IP address uses a series of four numbers that are expressed in dot notation, for example, 194.182.1.1.

Field	Description
Interfaces	The **Interfaces** field displays which of the six physical LAN ports are associated with the subnet. The possible ports are: P1 (port 1), P2, P3, P4, P5, and P6 (from left to right facing the front of the switch). The administrator assigns a port to a subnet to enable access to the device(s) connected to that port. The administrator can assign a port to only one subnet. The Interfaces field also lists the WLANs that are associated with the subnet.

Step 2: Configure Subnets

The WS 2000 Network Management System allows the administrator to define and refine the configuration of the enabled subnets. Each of three subnets (short for "subnetworks") can be configured as an identifiably separate part of the switch-managed Local Area Network (LAN). Each subnet can include some combination of assigned ports and associated Wireless LANs (WLANs).To configure an enabled subnet, select the subnet name from the **Network Configuration** --> **LAN** list in the left. The following screen will appear for the selected subnet.



1. Change the **Name** of the subnet to use a descriptive name that indicates something about the subnet. The name can contain seven characters, including spaces and numbers. It will appear in the left menu under the LAN menu item.
2. Set an **IP address** to be used for the subnet. This is how the switch will refer specifically to this subnet. This could be a WAN address; but more likely it will be a non-routable address. An IP address uses a series of four numbers that are expressed in dot notation, for example, 194.182.1.1.

3. Set the **Network Mask** for the **IP address**. A network mask uses a series of four numbers that are expressed in dot notation, similar to an IP number. For example, 255.255.255.0 is a network mask.

   Select a port or WLAN from the **Interfaces** drop-down menu to associate it with the subnet. Six LAN ports are available on the switch. Assign from one to six ports to a subnet. Two subnets cannot use the same port. However, multiple ports can be assigned to one subnet.

   Three WLANs are available. WLAN assignments are logical designations. Associate from zero to three WLANs with a subnet. Two subnets cannot use the same WLAN. However, multiple WLANs can be associated with one subnet. If two or three WLANs are associated with one subnet, each port dedicated to that subnet can use any of the associated WLANs.

4. Click on the **Add** button to add it to the **Interfaces** list.

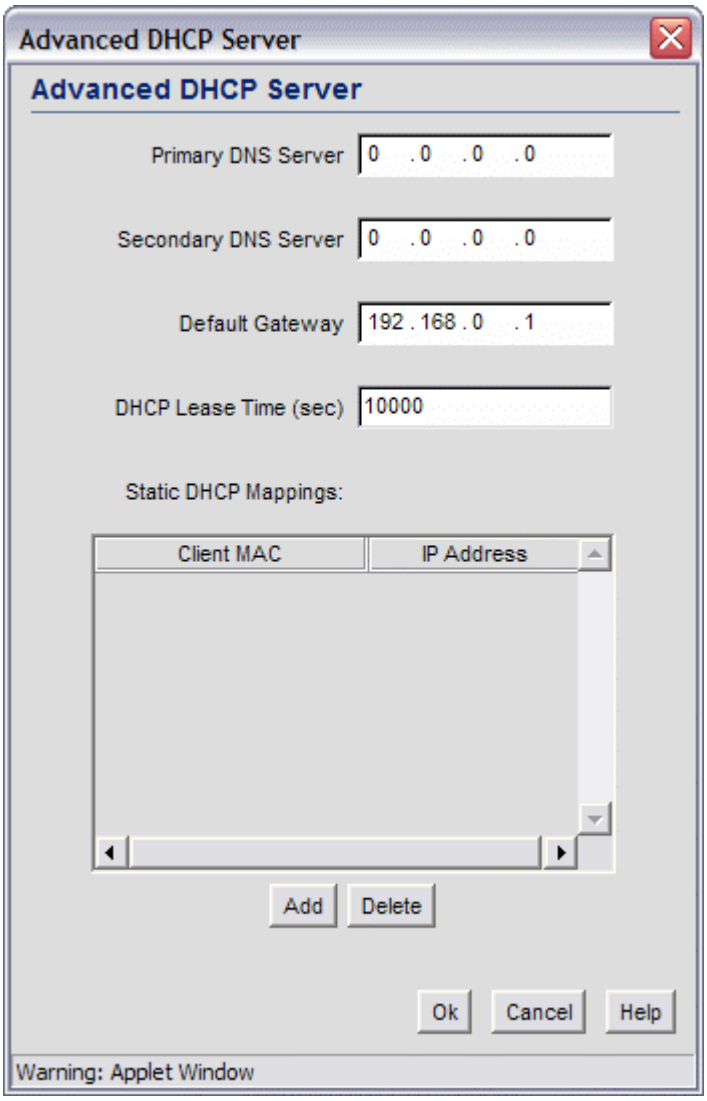
   Note that wireless devices cannot access the switch unless a WLAN is configured and associated with a subnet. (This process is described in Configuring the Wireless LAN.)

The DHCP Configuration

DHCP is a protocol that includes mechanisms for IP address allocation and delivery of host-specific configuration parameters from a DHCP server to a host. Some of these parameters are IP address, network mask, and gateway. The switch includes internal DHCP server and client features, and the subnet's interface can use either capability.

1. Click the appropriate radio button to select one DHCP setting for the subnet's interfaces:
   - Select **This interface does not use DHCP** to disable DHCP on this subnet and specify IP addresses manually.
   - Select **This interface is a DHCP Client** if this subnet obtains IP parameters from a DHCP server outside the switch.
   - Select **This interface is a DHCP Server** to enable the switch's DHCP server features.
2. If **This interface is a DHCP Server** is the selected option, fill in the **Address Assignment Range** fields. These fields allow the administrator to assign a range of IP addresses to devices as they connect.
3. Set the **Advanced Settings**, if necessary.
4. Click the **Apply** button to save all changes.

Advanced DHCP Settings



1. Click the **Advanced DHCP Server** button to display a sub-screen to further customize IP address allocation (on right).
2. Specify the address of a **Primary DNS server**. The Internet Server Provider (ISP) or a network administrator can provide this address. A DNS server translates a domain name, such as www.symbol.com, into an IP address that networks can use.
3. Specify the address of a **Secondary DNS server** if one is available.
4. Specify a **DHCP Lease Time** period in seconds for available IP addresses. The DHCP server grants an IP address for as long as it remains in active use. The lease time is the number of seconds that an IP address is reserved for re-connection after its last use. Using very short leases, DHCP can dynamically reconfigure networks in which there are more computers than there are available IP addresses. This is useful, for example, in education and customer environments where mobile-unit users change frequently. Use longer leases if there are fewer users.

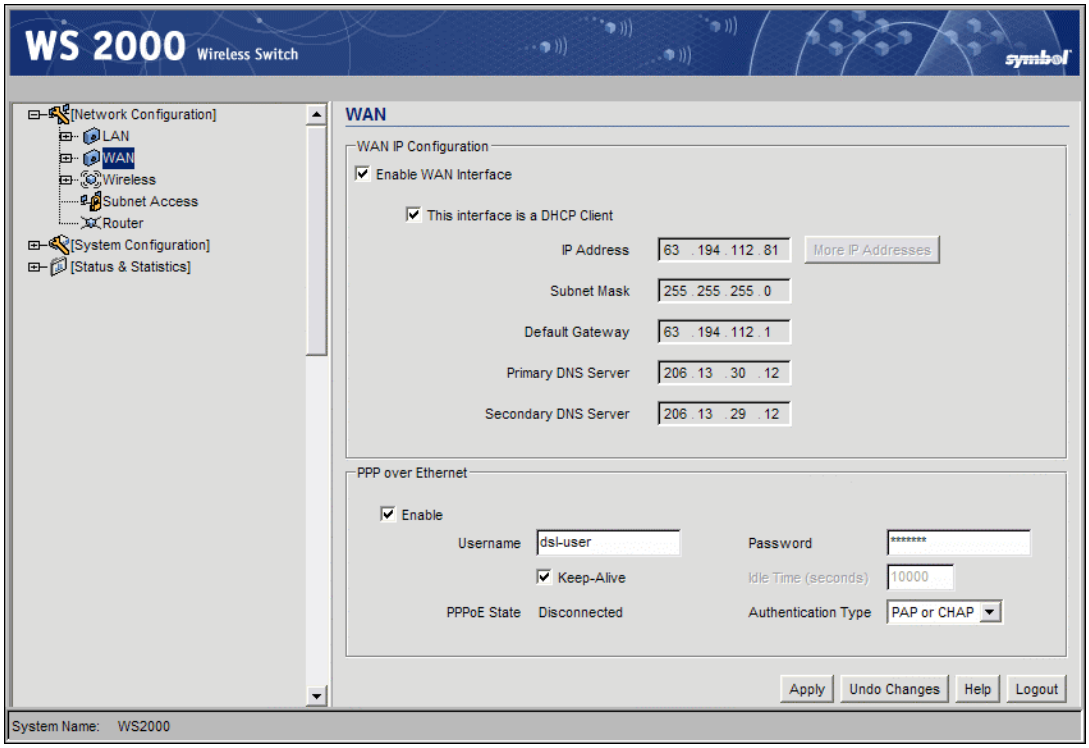
5. Use the **Static Mappings** table to associate static (or fixed) IP addresses with MAC addresses of specific wireless devices. Every wireless, 802.11x-standard device has a unique Media Access Control (MAC) address. This address is the device's hard-coded hardware number (shown on the bottom or back). An example of a MAC address is 00:09:5B:45:9B:07.

   This MAC table of specified devices provides corresponding static IP addresses for users, mobile units, and applications that may prefer or require such access.

Step 3: Configure the WAN Interface

A Wide Area Network (WAN) is a widely dispersed telecommunications network. In a corporate environment, the WAN port might connect to a larger corporate network. For a small business, the WAN port might connect to a DSL or cable modem to access the Internet.

The administrator needs to enter the WAN configuration information. The WS 2000 Wireless Switch includes one WAN port. In order to set up communications with the outside world, select **Network Configuration** --> **WAN** from the left menu. The following WAN configuration page appears.



Communicating with the Outside World

1. Use the **Enable WAN Interface** checkbox to enable a connection between the switch and a larger network or the outside world through the WAN port, check the **Enable WAN Interface** checkbox.
2. Check **This interface is a DHCP Client** checkbox to enable Dynamic Host Configuration Protocol (DHCP) for the WAN connection. If **This interface is DHCP Client** is checked, the switch is limited to one WAN IP address. This choice is required when:

- The host router or switch on the WAN is communicating with the WS 2000 Wireless Switch using DHCP.
- The switch is interfacing with an Internet Service Provider (ISP) that uses DHCP addressing.

Note: This setting is independent from the DHCP settings for the switch's internal subnets.

3. It is not necessary to specify the IP Address or any of the other fields on the top section of this form when the WS 2000 wireless switch is set as a DHCP Client. The network host (router, switch, or modem) will provide these values each time it makes a connection with the wireless switch.
4. If the DHCP setting is not checked, fill in the information in this area. To find out the information to enter into these fields, contact the network administrator or the ISP that provided the cable modem or DSL router. All the fields below take standard IP addresses of the form xxx.xxx.xxx.xxx.
   - The **IP Address** refers to the IP address that the outside world will use to address the WS 2000 Wireless Switch.
   - Click the **More IP Addresses** button to specify additional static IP addresses for the switch. Additional IP addresses are required when users within the LAN need dedicated IP addresses, or when servers in the LAN need to be accessed (addressed) by the outside world. The pop-up window allows the administrator to enter up to eight WAN IP addresses for the switch.
   - The **Subnet Mask** is the mask used for the WAN.
   - The **Default Gateway** is the address of the device that provides the connection to the WAN (often a cable modem or DSL router).
   - The two DNS Server fields specify DNS addresses of servers that can translate domain names, such as www.symbol.com, into IP addresses that the network uses when passing information. The **Secondary DNS Server** acts as a backup to the **Primary DNS Server**, when the primary server is not responding.

Setting Up Point-to-Point over Ethernet (PPPoE) Communication

PPPoE provides the ability to connect a network of hosts through a simple device to a remote access concentrator. Many DSL providers require that their clients communicate using this protocol. The facility allows the ISP to control access, billing, and type of service provided to clients on a per-user or per-site basis. Check with the network administrator or ISP to determine whether to enable this feature, and, if so, find out the username and password required for authentication.

1. Check **Enable** in the PPP over Ethernet area to enable the PPPoE protocol for high-speed connections.
2. Enter the **Username** and **Password** required for authentication. The username and password is for the switch's router to use when connecting to the ISP. When the Internet session starts, the ISP authenticates the username.
3. Set the **Idle Time** to an appropriate number. This number is the amount of time the PPPoE connection will be idle before it disconnects. The 10000 second (default idle time) is appropriate for most situations.

4. Check **Keep Alive** to instruct the switch to continue occasional communications over the WAN even when client communications to the WAN are idle. Some ISPs terminate inactive connections, while others do not. In either case, enabling Keep-Alive mode keeps the switch's WAN connection alive, even when there is no traffic. If the ISP drops the connection after so much idle time, the switch automatically reestablishes the connection to the ISP.
5. Select the appropriate WAN authentication method from the drop-down menu. Collect this information from the network administrator. Select between **None**, **PAP**, **CHAP**, or **PAP or CHAP**.

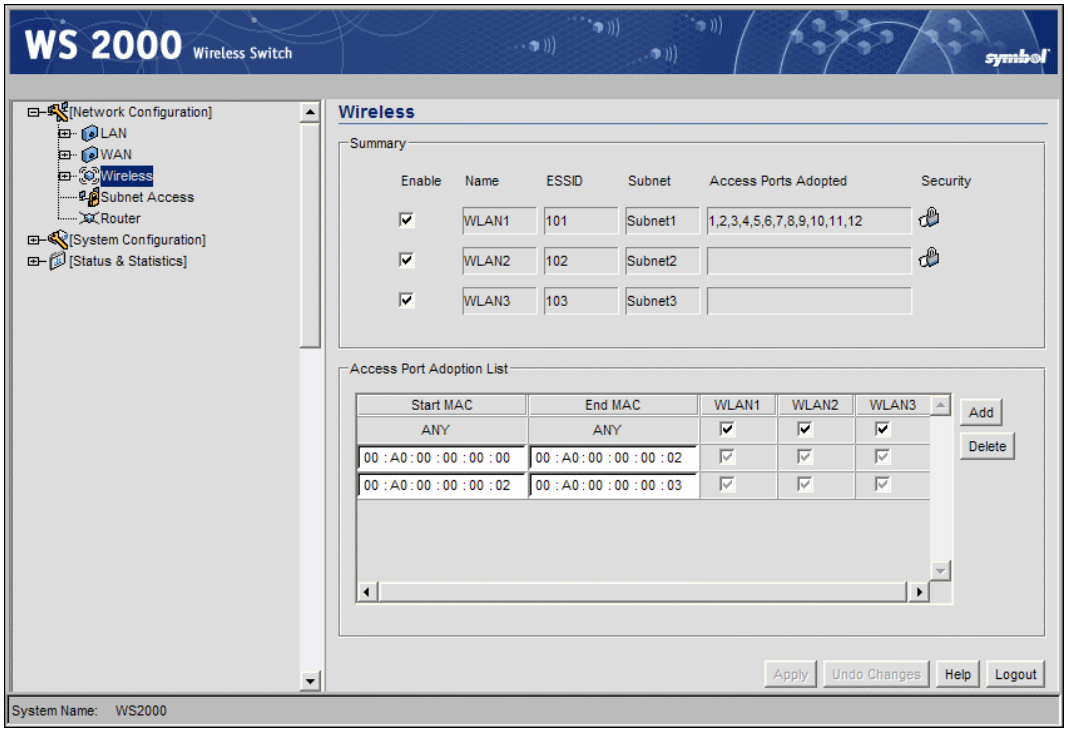
CHAP	A type of authentication in which the person logging in uses secret information and some special mathematical operations to come up with a number value. The server he or she is logging into knows the same secret value and performs the same mathematical operations. If the results match, the person is authorized to access the server. One of the numbers in the mathematical operation is changed after every log-in, to protect against an intruder secretly copying a valid authentication session and replaying it later to log in.
PAP	An identity verification method used to send a user name and password over a network to a computer that compares the user name and password to a table listing authorized users. This method of authentication is less secure, because the user name and password travel as clear text that a hacker could read.

6. Click the **Apply** button to save changes.

Step 4: Enable Wireless LANs (WLANs)

The WS 2000 Wireless Switch works either in a wired or wireless environment; however, the power of the switch is associated with its support of wireless networks. In order to use the wireless features of the switch, the administrator needs to enable one, two or three wireless LANs (WLANs).

To start the WLAN configuration process, select the **Network Configuration** --> **Wireless** item from the left menu. The following Wireless summary screen appears.



Wireless Summary Area

The top portion of the window displays a summary of the WLANs that are currently defined. This is the screen in which the administrator can enable or disable a WLAN. At first, three WLANs will be listed WLAN1, WLAN2, and WLAN3; however, only WLAN1 will be enabled.

1. To enable either WLAN2 or WLAN3 check the appropriate checkboxes to the left of the WLAN name. When the administrator enables one of the WLANs, the name of an enabled WLAN shows up as an item on the list of WLANs that reside under **Wireless** in the left menu (after clicking the **Apply** button). When an administrator disables a WLAN, it disappears from the menu tree. A WLAN cannot be fully configured unless it is enabled.
2. Assign the enabled WLANs descriptive names. The administrator can change the **Name** of any of the WLANs in this field. This change will affect several other screens and the interface will change the name in the left menu tree.
3. By default, the switch assigns consecutive Extended Service Set Identification (ESSIDs). This is the name that users will see when accessing the wireless network. The **ESSID** can be given any recognizable alphanumeric string up to 32 characters in length.
4. An icon of a lock will appear under the **Security** heading if any wireless encryption or authentication is enabled for the WLAN.

The current settings for the associated Subnet and adopted Access Ports are also displayed on this screen; however, the screen associated with each WLAN (under **Network Configuration** --> **Wireless**) is where the settings and rules for adopting Access Ports can be modified.

Access Port Adoption

Use this list to adopt detected Access Ports and to assign them to a particular WLAN. The switch can adopt up to six Access Ports at a time, but the list of allowed Access-Port addresses (displayed in this area) can exceed six in number. A dual-radio 802.11a/b Access Port counts as one Access Port with respect to the maximum allowed; however, each radio will be listed as a separate Access Port.

This adoption list identifies each Access Port by its Media Access Control (MAC) address. This address is the Access Port's hard-coded hardware number that is printed on the bottom of the device. An example of a MAC address is 00:09:5B:45:9B:07.

1. To adopt an access port, click the **Add** button to add a new criteria line to the table.
2. Specify the following fields:

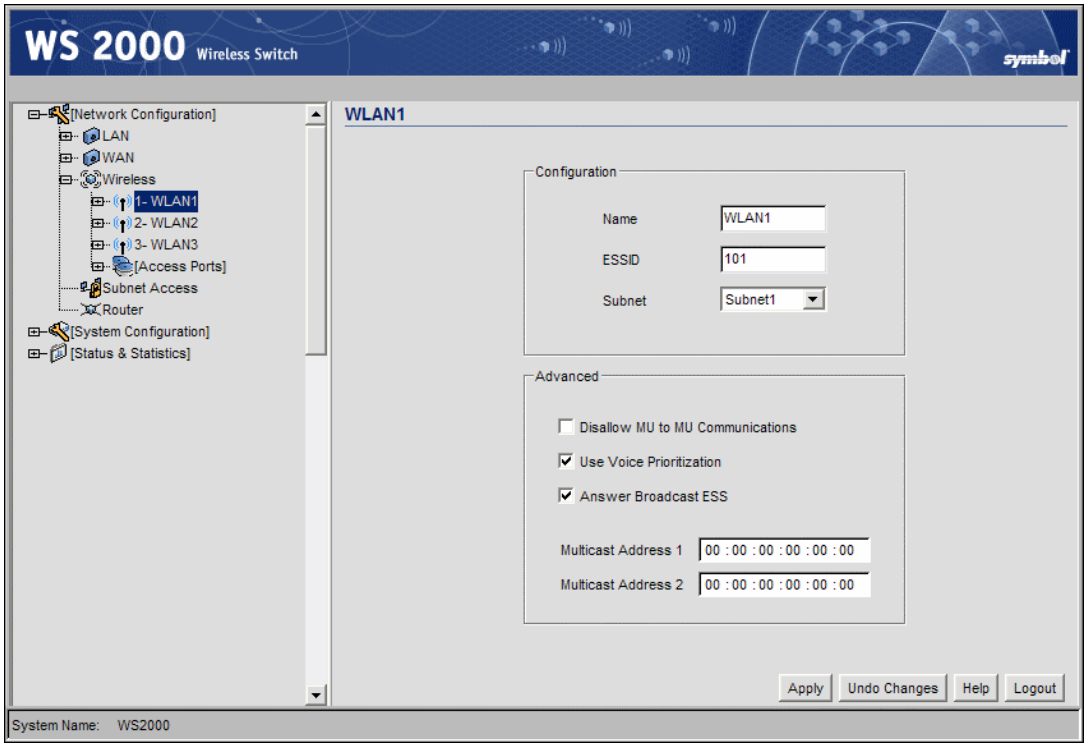
Field	Description
Start MAC	This field contains the lowest value in a range of MAC addresses that will use this particular adoption criteria. To specify a single MAC address instead of a range, enter it in this field and leave the **End MAC** field blank.
End MAC	This field contains that highest number in a range of MAC addresses that will use this particular adoption criteria. If this value is empty, the Access Port adopted by this criteria must match the **Start MAC** field exactly.
WLAN columns	The next one to three columns have the same names as the WLANs that are enabled in the upper portion of the screen. Click on the checkbox for a specific WLAN to associate the Access Ports that match the MAC address range with the checked WLANs.

Note: The default setting for the switch has both the** Start MAC **and** End MAC **addresses set to "ANY", and all enabled WLANs checked. This setting allows all the WLANs to adopt any Access Port that it detects, automatically.

3. Click the **Apply** button to save changes.

Step 5: Configure WLANs

The **Network Configuration** --> **Wireless** window (covered in Step 4) is where WLANs are enabled; however, the **Network Configuration** --> **Wireless** --> <WLAN name> screen is where the administrator configures each WLAN, once it is enabled. The screen is titled with the name of the WLAN.



Within the WLAN window, the administrator changes both standard and advanced configuration features of the WLAN.

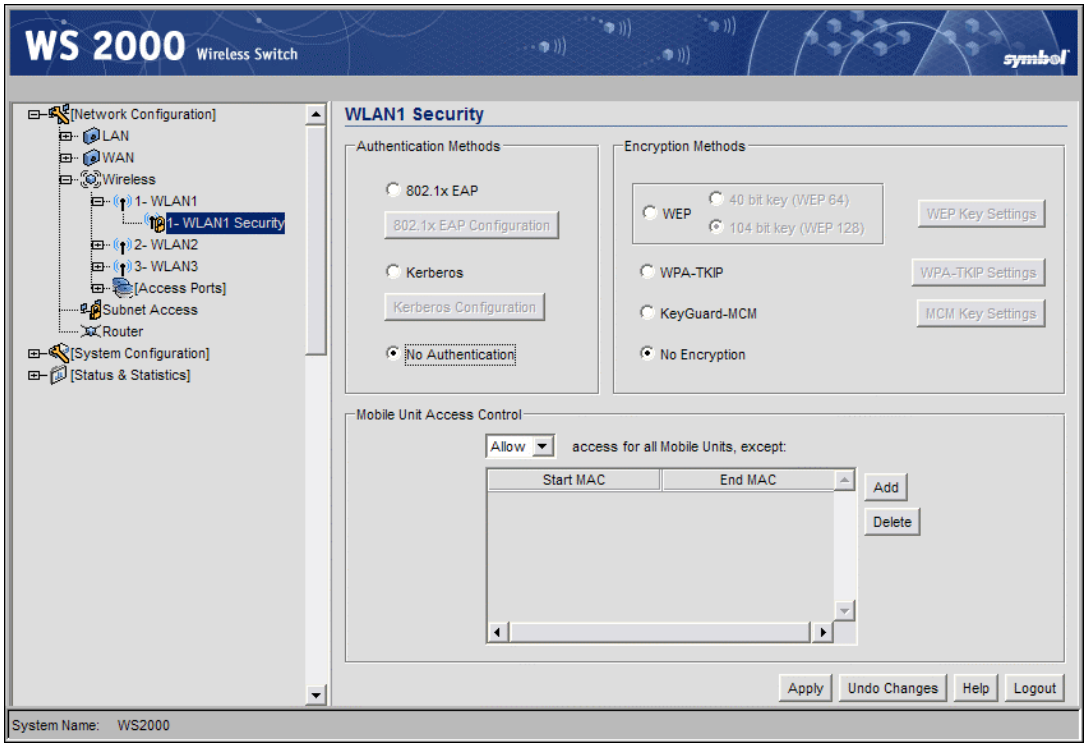
Field	Description
Name	Rename the WLAN in this field, if desired. Character spaces are allowed. This change affects several other screens and the interface will also change the name in the left menu tree. Symbol Technologies recommends the use of descriptive names for WLANs.
ESSID	Specify an Extended Service Set Identification (ESSID) for the WLAN. The **ESSID** is a alphanumeric string up to 32 characters. Its purpose is to identify one or more access ports that are associated with the WLAN.
Subnet	This field provides a pull-down list of the enabled subnets. Select the subnet to associate with the current WLAN.

The lower section of the WLAN window provides several advanced settings that the administrator might need to modify; however, the default settings are typically sufficient for most installations. For more information, refer to How to Configure the Advanced WLAN Settings.

Step 6: Configure WLAN Security

In the previous step, the administrator set parameters for each WLAN that fine tune the performance of the WLAN. In addition, the administrator can set the type and level of security for each WLAN. These security measures do not control communications from the WAN; instead, they control communication from the clients within the WLAN.

In the **Network Configuration** --> **Wireless** --> <WLAN name> --> <WLAN Name> **Security** screen, the administrator can set the user authentication method and the encryption method, as well as define a set of rules that control which MUs can communicate through the WLAN.



Setting the Authentication Method

The authentication method sets a challenge-response procedure for validating user credentials such as username, password, and sometimes secret-key information. The WS 2000 Wireless Switch provides two methods for authenticating users: 802.1x EAP and Kerberos. The administrator can select between these two methods. If WLAN security is not an issue, an administrator can decide not to enable authentication (**No Authentication**), because authentication protocols create overhead for the switch's processor.

802.1x EAP Authentication

The IEEE 802.1x is an authentication standard that ties EAP to both wired and wireless LAN applications. EAP provides effective authentication with or without IEEE 802.1x Wired Equivalent Privacy (WEP) encryption, or with no encryption at all. EAP supports multiple authentication measures. It requires that the site have a authentication (Remote Dial-In User Service) server on the wired side of the access port. All other packet types are blocked until the authentication server verifies the client's identity. To set up 802.1x EAP authentication:

1. Select the **802.1x EAP** radio button to enable the 802.1x Extensible Authentication Protocol (EAP).
2. Click the **802.1x EAP Configuration** button to display a sub-screen for specific authentication settings. For more information about how to configure these settings, go to How to Configure 802.1 EAP Authentication.
3. Click the **Apply** button to save changes.

Kerberos Authentication

secret-key cryptography. Using this protocol, a client can prove its identity to a server (and vice versa) across an insecure network connection. After a client and server use Kerberos to prove their identity, they can encrypt all communications to assure privacy and data integrity.

1. Select the **Kerberos** radio button to enable Kerberos authentication.
2. Click the **Kerberos Configuration** button to display a sub-screen for authentication settings. To see the details on how to set up the Kerberos authentication, refer to How to Configure Kerberos Authentication.
3. Click the **Apply** button to save changes.
4. Make sure that **NTP** is enabled (go to **System Configuration** --> **NTP Servers** from the left menu). It is required for Kerberos Authentication. For more information, see How to Configure an NTP Server.

Setting the Encryption Method

Encryption applies a specific algorithm to data to alter its appearance and prevent unauthorized reading. Decryption applies the algorithm in reverse to restore the data to its original form. Sender and receiver employ the same encryption/decryption method.

The WS 2000 Wireless Switch provides three methods for data encryption: WEP, WPA-TKIP, and KeyGuard-MCM. The WPA-TKIP and KeyGuard-MCM methods use WEP 104-bit key encryption. WPA-TKIP offers the highest level of security among the encryption methods available with the switch.

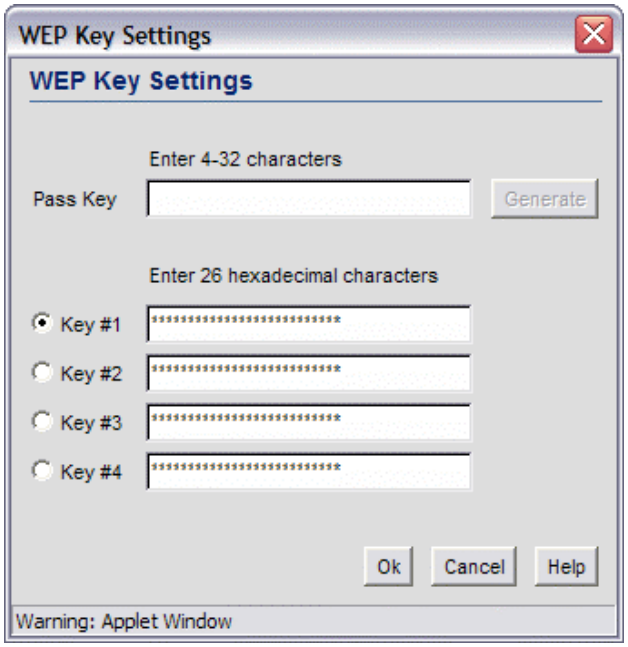
Configuring WEP Encryption

Wired Equivalent Privacy (WEP) is a security protocol specified in the IEEE Wireless Fidelity (Wi-Fi) standard, 802.11b. WEP is designed to provide a WLAN with a level of security and privacy comparable to that of a wired LAN. WEP might be all that a small-business user needs for the simple encryption of wireless data. However, networks that require more security are at risk from a WEP flaw. The existing 802.11 standard alone offers administrators no effective method to update keys. Key changes require the manual reconfiguration of each access port. An unauthorized person with a sniffing tool can monitor a network for less than a day and decode its encrypted messages.

WEP is available in two encryption modes: 40 bit (also called 64-bit) and 104 bit (also called 128 bit). The 104-bit encryption mode provides a longer algorithm that takes longer to decode than that of the 40-bit encryption mode.

Note: The 104-bit encryption mode allows devices using keys 104-bit and devices 40-bit keys to talk to each other using 40-bit keys if the 104-bit devices permit this option.

1. Select the **WEP** radio button to enable the Wired Equivalent Privacy (WEP) protocol.
2. Choose between the **40-bit key (WEP 64)** and **104-bit key (WEP 128)** option by selecting the appropriate radio button.
3. To use WEP encryption with the **No Authentication** selection, click the **WEP Key Settings** button to display a sub-screen for entering keys.



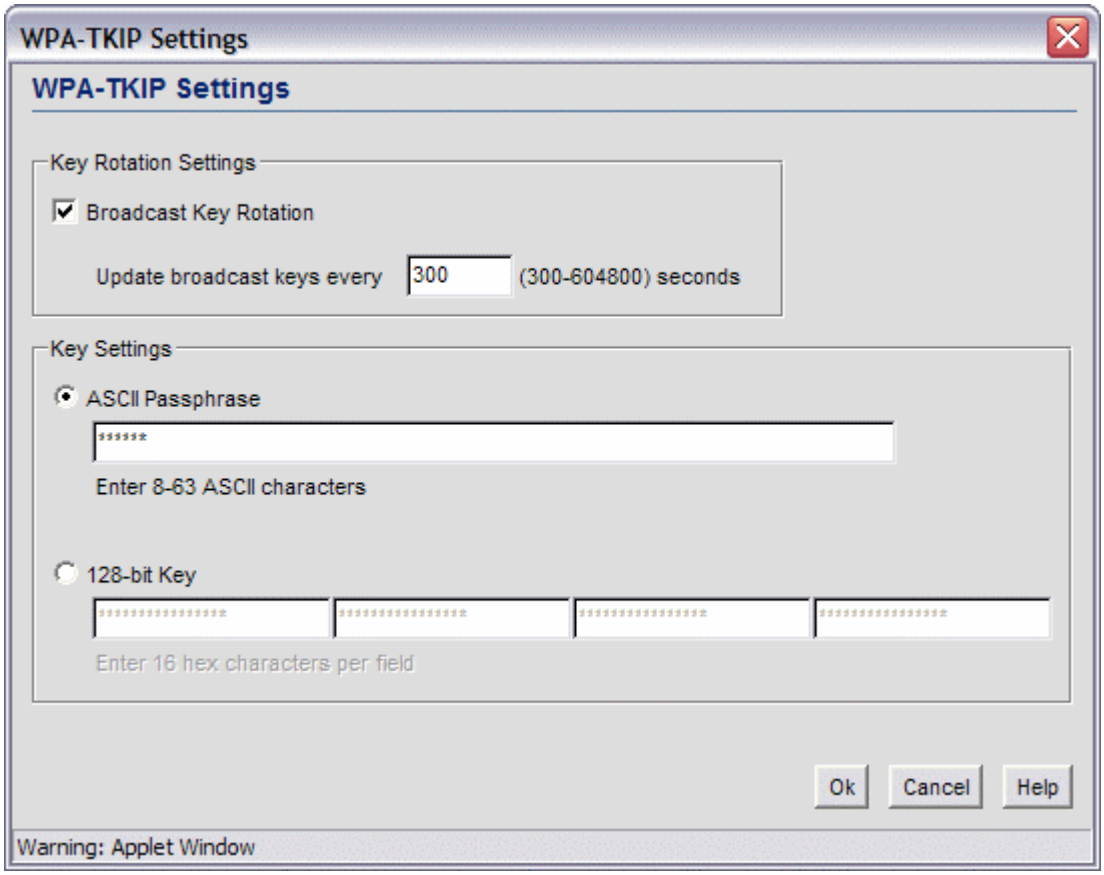
4. When finished, click the **OK** button to close this screen.
5. Specify a **Pass Key** and click the **Generate** button. The pass key can be any alphanumeric string. The switch, other proprietary routers, and Symbol cards in mobile units (MUs) use an algorithm to convert an ASCII string to the same hexadecimal number, but this conversion is not required for a wireless connection.
6. Use the **Key #1-4** fields to specify key numbers that use 26 hexadecimal characters. Select one of these keys for active use by selecting its radio button.
7. Click the **Apply** button on the WLAN Security screen to save changes.

Configuring WPA-TKIP

EncryptionWi-Fi Protected Access (WPA) is specified in the IEEE Wireless Fidelity (Wi-Fi) standard, 802.11i. This security standard provides more sophisticated data encryption than WEP. WPA is designed for corporate networks and small-business environments where more wireless traffic allows quicker discovery of encryption keys by an unauthorized person.

WPA's encryption method is Temporal Key Integrity Protocol (TKIP). TKIP addresses WEP weaknesses with a re-keying mechanism, a per-packet mixing function, a message integrity check, and an extended initialization vector. WPA also provides strong user authentication that is based on 802.1x EAP.

1. Select the **WPA-TKIP** radio button to enable Wi-Fi Protected Access (WPA) with Temporal Key Integrity Protocol (TKIP).
2. To use WPA-TKIP encryption with **802.1x EAP authentication** or the **No Authentication** selection, click the **WPA-TKIP Settings** button to display a sub-screen for key and key rotation settings.



3. Check the **Broadcast Key Rotation** checkbox to enable or disable the broadcasting of encryption-key changes to mobile units.
4. Specify a time period in seconds for broadcasting encryption-key changes to mobile units. Set key broadcasts to a shorter time interval (at least 300 seconds) for tighter security on this WLAN's wireless connections. Set key broadcasts to a longer time interval (at most, 80,000 seconds) to relax security on wireless connections.
5. A Pre-Shared Key (PSK) is an Internet Protocol security (IPSec) technology that uses a shared, secret key for authentication in IPSec policy. IPSec is a set of industry-standard, cryptography-based protection services and protocols. IPSec protects all protocols in the TCP/IP protocol suite and Internet communications by using Layer Two Tunneling Protocol (L2TP). Use pre-shared key authentication only in a WLAN environment intended for relaxed security.

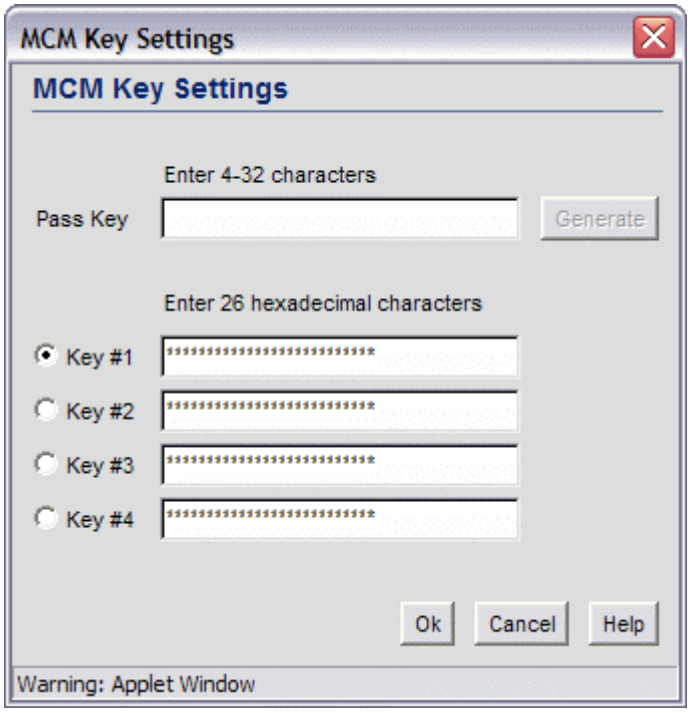
   The administrator can specify the key either as an ASCII passphrase or as a 128-bit key. All WLAN clients must use the same PSK.
6. Select either the **ASCII Passphrase** or **128-bit Key** radio button.
7. If **ASCII Passphrase** is selected, specify a 8 to 63 character alphanumeric string.

   The alphanumeric string allows character spaces. The switch converts the string to a numeric value.
8. To use the **128-bit Key** option, enter 16 hexadecimal characters into each of four fields.
9. Click the **OK** button to return to the WLAN security screen.
10. Click the **Apply** button on the WLAN Security screen to save changes.

KeyGuard-MCM

KeyGuard-MCM is a proprietary encryption method developed by Symbol Technologies. KeyGuard is Symbol's enhancement to WEP encryption and can work with any WEP device. This encryption method rotates WEP keys for devices that support the method. This encryption implementation is based on the IEEE Wireless Fidelity (Wi-Fi) standard, 802.11i.

1. Select the **KeyGuard-MCM** radio button to enable the KeyGuard-MCM encryption method.
2. To use KeyGuard-MCM encryption with the No Authentication selection, click the **MCM Key** Settings button to display a sub-screen for entering keys. (Note that these are the same keys specified for WEP encryption.



3. Select a **Key #** radio button to enter to enter or change a passkey.
4. Specify a pass key string in the **Pass Key** field. The pass key can be any alphanumeric string. The switch, other proprietary routers, and Symbol cards in mobile units (MUs) use an algorithm to convert an ASCII string to the same hexadecimal number, but this conversion is not required for a wireless connection.
5. Click the **Generate** button and the pass key will be entered in the appropriate **Key #** field.
6. When finished entering pass keys, click the **OK** button to close this screen.
7. Click the **Apply** button on the WLAN Security screen to save changes.

No Encryption

If **No Authentication** is selected, the **No Encryption** radio button can disable encryption on this WLAN. If security is not an issue, this setting avoids the overhead that an encryption protocol demands on the switch's processor.

Mobile Unit Access Control List (ACL)

Use this list to specify which mobile units can or cannot gain access to the WLAN. The list employs an adoption rule for allowing or denying specific mobile units by way of exception.

1. Select **Allow** or **Deny** from the pull-down list. This rule applies to all mobile units except those listed in the table. If **Allow** is visible, the access criteria (MAC addresses) will be used to indicated which mobile units will be allowed access to the Access Port. If **Deny** is visible, the access criteria will be used to indicated which mobile units should not be allowed access.
2. Click the **Add** button to add a new entry to the list.
3. Each entry in the table specifies one or more MAC address to be used to match with a mobile unit's MAC address that is attempting to gain access to the WLAN. Specify a single address (by specifying **Start Address** only) or a range of MAC access (by using both the **Start Address** and the **End Address**).

   For example, if Allow is selected, all mobile units that match any of the specified MAC addresses or MAC address ranges in the table can be adopted by the WLAN. If Deny is selected, all mobile units that match any of the specified MAC addresses or MAC address ranges in the table cannot be adopted by the WLAN.
4. Click the **Apply** button to save changes.

Step 7: Configure Access Ports

The WS 2000 Wireless Switch automatically detects Access Ports when they are attached to one of the switch's LAN ports. When the switch starts communication with an Access Port that can be adopted by the switch, it uploads the firmware appropriate for the Access Port. At this time, the Access Port becomes active. The switch also automatically adds the Access Port to the list of known ports under the left menu item, **Network Configuration** --> **Wireless** --> **Access Ports**--> <Access Port Name>.

For an Access Port to be adopted by the WS 2000 Wireless Switch, three things must be configured:

1. The **Country** field in the System Settings screen must be set.
2. The Access Port's MAC address must be set as one of the addresses that can be adopted by one of the enabled WLANs. (see Step 4)
3. A WLAN that can adopt Access Port must be associated with an enabled subnet. (see Step 5)

The switch can adopt up to six Access Ports at a time, but the number of Access Ports listed can exceed six in number. A dual-radio 802.11a/b Access Port counts as one Access Port with respect to the maximum allowed; however, each radio will be listed as a separate Access Port in the list of Access Ports.

The switch creates a default name for a newly found switch consisting of "AP" and a unique number. During this detection process, the switch collects the following information from the Access Port:

- **MAC address**—Each access port has a unique Media Access Control (MAC) address by which it is identified. This address is burned into the ROM of the access port. Also, this address appears on a sticker attached to the bottom of the Access Port.

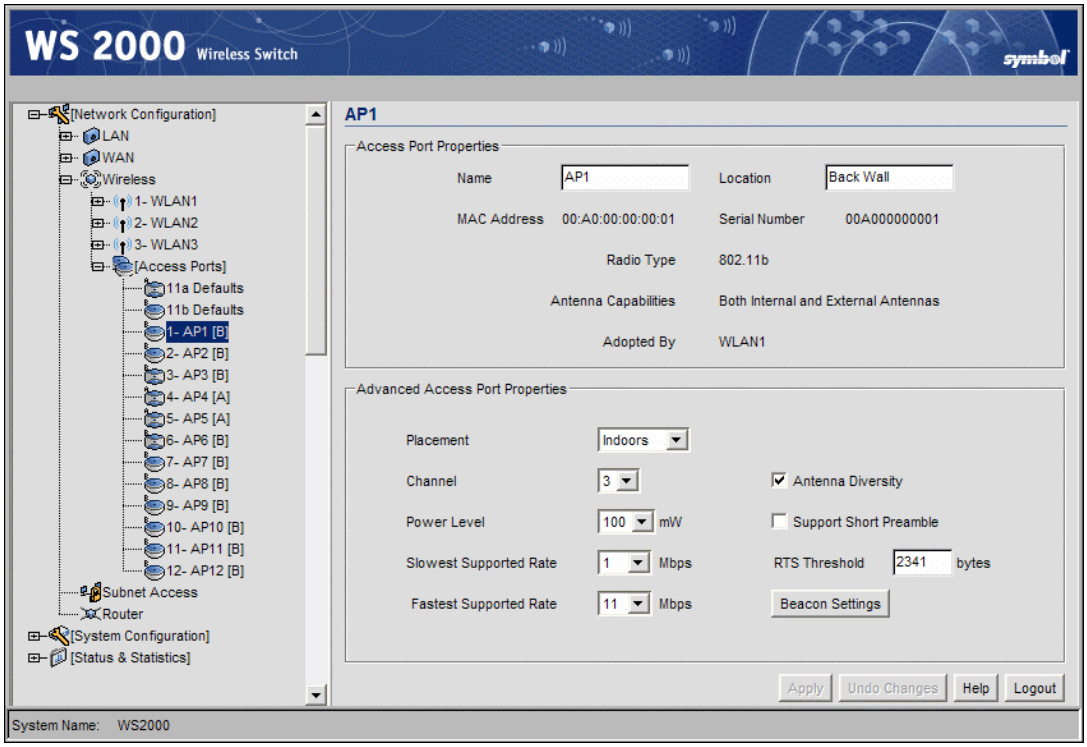
- **Radio type**—This field indicates the wireless protocol that the Access Port follows. The WS 2000 Wireless Switch supports 802.11b and 802.11 a/b dual-radio Access Ports.
- **Physical port**—This field specifies the physical LAN port on the switch to which the Access Port is connected.
- **Adopted by**—This field contains a list of defined WLANs that have adopted this Access Port (see Enable Wireless LANs and Access Port Adoption for the process of adopting an Access Port)

The switch also sets several default values for the channel and the power level based upon the Location information set in the System Settings screen and upon settings in the Default Access Port Settings screen for the radio type.

The WS 2000 Wireless Switch GUI also allows the administrator to refine the basic Access Port configuration that is set at the point of detection. To examine or change that information:

4. Select **Network Configuration** --> **Wireless** --> **Access Ports** from the left menu and then click the + to the left of the menu item. The detected Access Ports will be listed under the menu item.
5. Select the Access Port item to examine or modify. There are two ways to distinguish between Access Ports when they are labeled with the default “AP#” name.
   - Look on the bottom of the Access Ports and take note of the MAC address (which looks like AA:BB:CC:DD EE:FF) and compare it with the MAC address in the Access Port windows.
   - Note the order in which Access Ports were plugged into the switch. The Access Port numbers are assigned in order, starting with AP1.

   The following screen is displayed with the settings for the selected Access Port:



6. From this screen, the administrator can change several pieces of information about each Access Port.

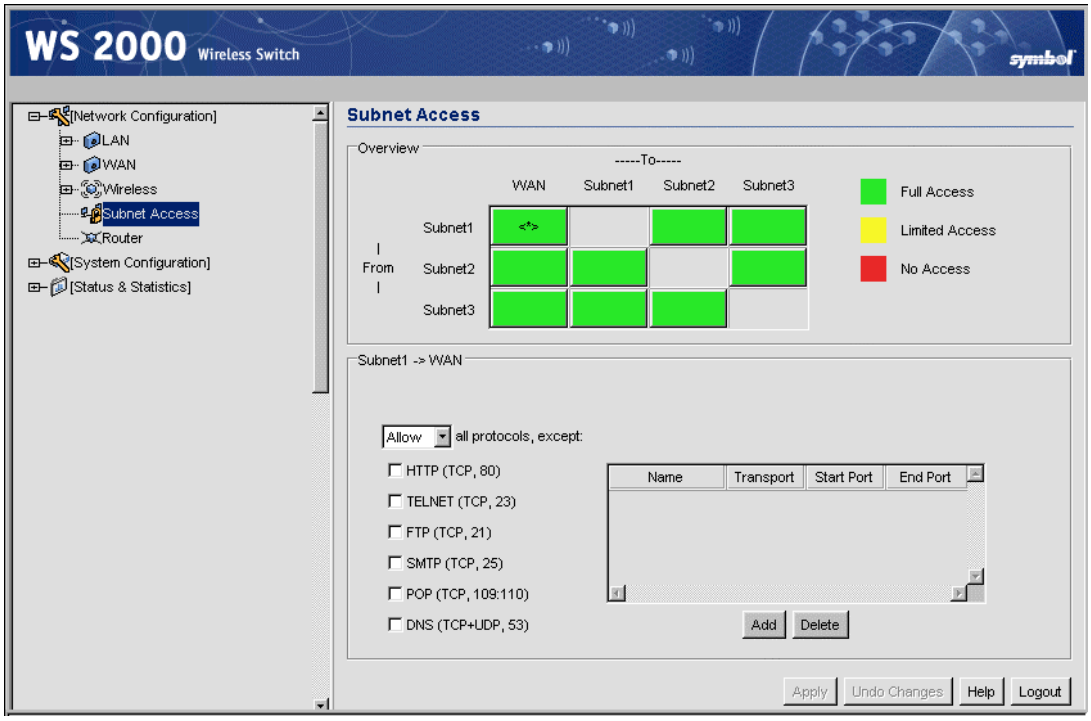
Field	Description
Name	Administrators can change the names of the Access Ports from **Access Port#** to something much more descriptive so that they can easily identify which Access Port is being referenced in the various screens and in the left menu. The name is limited to a string of 13 characters.
Location	This field is a memory aid for the administrator. Enter text that describes where the Access Port is physically located. The name is limited to a string of 13 characters.
Placement	Select either **Indoors** or **Outdoors** from the **Placement** pop-up menu. The setting will affect the selection available for several of the other advanced settings.
Channel	Specify a channel for communications between the Access Port and mobile units. The range of legally approved communications channels varies depending on the installation location. It is best to use a different channel number for each Access Port. Communications will be the clearest for nearby Access Ports if the channel numbers are 5 numbers apart (1, 6, 11).
Power Level	Specify a **Power Level** in milliwatts (mW) for RF signal strength. The optimal power level is best determined by a site survey prior to installation. Available settings include 1, 5, 15, 30 and 100. Consult the site survey for recommendations for the power level. Set a higher power level to ensure RF coverage in WLAN environments that have more electromagnetic interference or greater distances between the Access Port and mobile units. Decrease the power level according to the proximity of other Access Ports. Overlapping RF coverage may cause lost packets and difficulty for roaming mobile units trying to engage an Access Port.

7. Click **Apply** to save changes.

This screen also provides the ability to change several advanced settings for the Access Ports. For more information, see Advanced Access Port Settings.

Step 8: Configure Subnet Access

The WS 2000 Network Management System allows the administrator to set up access rules for subnet-to-subnet and subnet-to-WAN communication. These access rules control communication between subnets and the outside world (the WAN). Select **Network Configuration** --> **Subnet Access** to get to the Subnet Access screen.



The Access Overview Table

In the overview table, each of the rectangles represents a subnet association. The three possible colors indicate the current access level, as defined, for each subnet association.

Color	Access Type	Description
Green	Full Access	No protocol exceptions (rules) are specified. All traffic may pass between these two areas.
Yellow	Limited Access	One or more protocol rules are specified. Specific protocols are either enabled or disabled between these two areas. Click the table cell of interest and look at the exceptions area in the lower half of the screen to determine the protocols that are either allowed or denied.
Red	No Access	All protocols are denied, without exception. No traffic will pass between these two areas.

The Access Exception Area

In the lower half of the screen, the access is controlled by specify rules that control the protocols that are allowed or denied between the two subnets or the subnet and the WAN. All rules are added to the exception table. The **Allow** or **Deny** menu item applies to all entries in the table. There are two ways to add entries (access rules) to the table. The first is by checking the checkboxes for specific protocols (on the left). The second is by adding rules for specific port numbers by clicking the **Add** button and filling in the necessary information. A combination of the two methods can be used to add multiple entries to the table.

You can allow or deny communication through specific protocols using the following process.

1. Click in a cell of the table that represents the subnet-to-subnet (or subnet-to-WAN) relationship to define. All access rules (if any are defined) appear in the table in the lower-half of the screen.
2. Use the pulldown menu above the list **Allow** or **Deny** all the entries specified in the exception table. You cannot allow some protocols (or ports) and deny others.
3. From the list of checkboxes on the left side, select those protocols to allow or deny. The protocols are automatically added to the table with the relevant Name, Transport, Start Port, and End Port information. The available protocols are:

Protocol	Transport, Port Used	Description
HTTP	TCP, 80	Hypertext Transfer Protocol (HTTP) is the protocol for transferring files on the World Wide Web. HTTP is an application protocol that runs on top of the TCP/IP suite of protocols, the foundation protocols for the Internet.
TELNET	TCP, 23	TELNET is the terminal emulation protocol of TCP/IP. TELNET uses TCP to achieve a virtual connection between server and client, then negotiates options on both sides of the connection.
FTP	TCP, 21	File Transfer Protocol (FTP) is an application protocol that uses the Internet's TCP/IP protocols. FTP provides a simple and efficient way to exchange files between computers on the Internet.
SMTP	TCP, 25	Simple Mail Transfer Protocol (SMTP) is a TCP/IP protocol used for sending and receiving email. Due to its limited ability to queue messages at the receiving end, SMTP is often used with POP3 or IMAP. SMTP sends the email, and then POP3 or IMAP receives the email.
POP	TCP, 109:110	Post Office Protocol (POP3) is a TCP/IP protocol intended to permit a workstation to dynamically access a maildrop on a server host. A workstation uses POP3 to retrieve email that the server is holding for it.
DNS	TCP+UDP, 53	Domain Name Service (DNS) protocol searches for resources using a database that is distributed among different name servers.

   - You can make changes to the information automatically filled into the table; however, note that changes in the selected transport type can change the port numbers that can be specified in the table.
4. To add an access rule for a protocol, port, or transport other than the ones available from the checkboxes on the left, click the **Add** button. An empty row is added to the table.
   - Specify a **Name** to identify the new access rule. This could be the name of a particular application, for example.

- Select a transport type from the **Transport** column's pulldown menu. The available transports are:

Transport	Description
ALL	This selection designates all of the protocols displayed in the table's pull-down list, as described below.
TCP	Transmission Control Protocol (TCP) is a set of rules used with Internet Protocol (IP) to send data as message units over the Internet. While IP handles the actual delivery of data, TCP keeps track of individual units of data called packets. Messages are divided into packets for efficient routing through the Internet.
UDP	User Datagram Protocol (UDP) is mostly used for broadcasting data over the Internet. Like TCP, UDP runs on top of Internet Protocol (IP) networks. Unlike TCP/IP, UDP/IP provides very few error recovery services and methods. UDP offers a way to directly connect, and then send and receive datagrams over an IP network.
ICMP	Internet Control Message Protocol (ICMP) is tightly integrated with IP. ICMP messages, delivered in IP packets, are used for out-of-band messages related to network operation. Because ICMP uses IP, ICMP packet delivery is unreliable. Hosts cannot count on receiving ICMP packets for a network problem.
AH	Authentication Header (AH) is one of the two key components of IPsec (IP Security Protocol). The other key component is Encapsulating Security Protocol (ESP), described below. AH provides authentication, proving the packet sender really is the sender, and the data really is the data sent. AH can be used in transport mode, providing security between two end points. Also, AH can be used in tunnel mode, providing security like that of a Virtual Private Network (VPN).
ESP	Encapsulating Security Protocol (ESP) is one of the two key components of IPsec (IP Security Protocol). The other key component is Authentication Header (AH), described above. ESP encrypts the payload of packets, and also provides authentication services. ESP can be used in transport mode, providing security between two end points. Also, ESP can be used in tunnel mode, providing security like that of a Virtual Private Network (VPN).
GRE	General Routing Encapsulation (GRE) supports VPNs across the Internet. GRE is a mechanism for encapsulating network layer protocols over any other network layer protocol. Such encapsulation allows routing of IP packets between private IP networks across an Internet that uses globally assigned IP addresses.

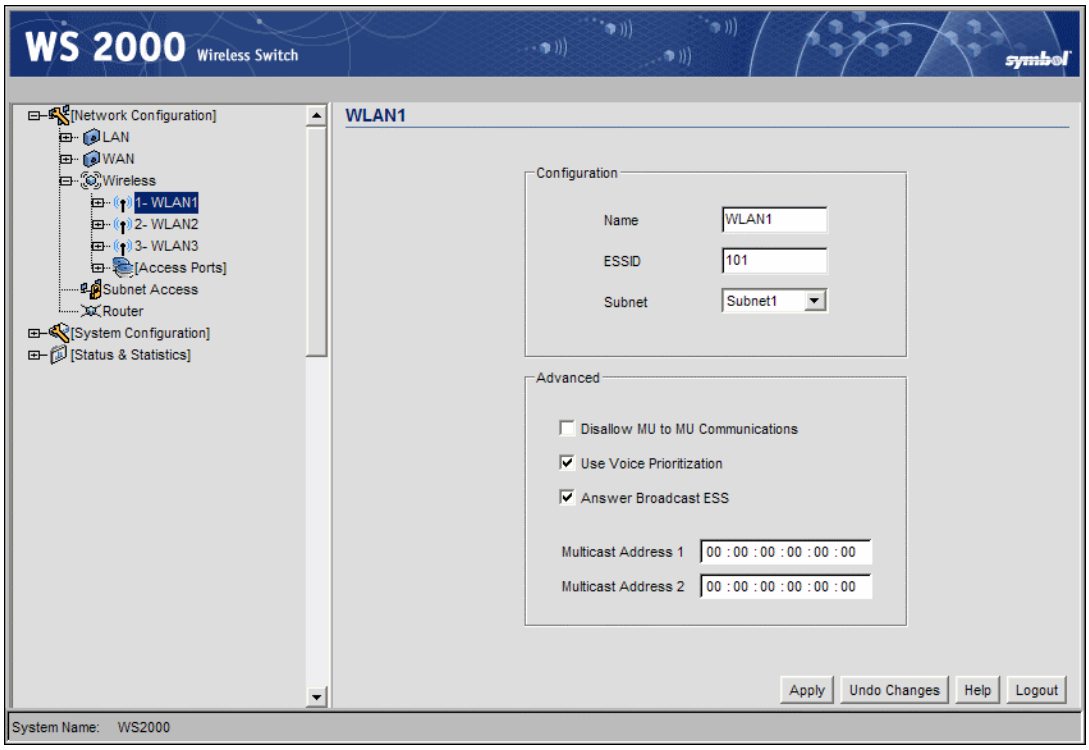
- Specify port information for the protocol. If a protocol uses only one port, enter the same port number in the **Start Port** and **End Port** columns, or leave the **End Port** column blank. Otherwise, use both columns for an entry that has a range of ports.

5. Click the **Apply** button to save changes.

Chapter 4. Advanced Configuration

WLAN—How to Configure Advanced Settings

The lower section of the WLAN screen provides several settings that the administrator might need to modify; however, the default settings are usually sufficient for most installations.

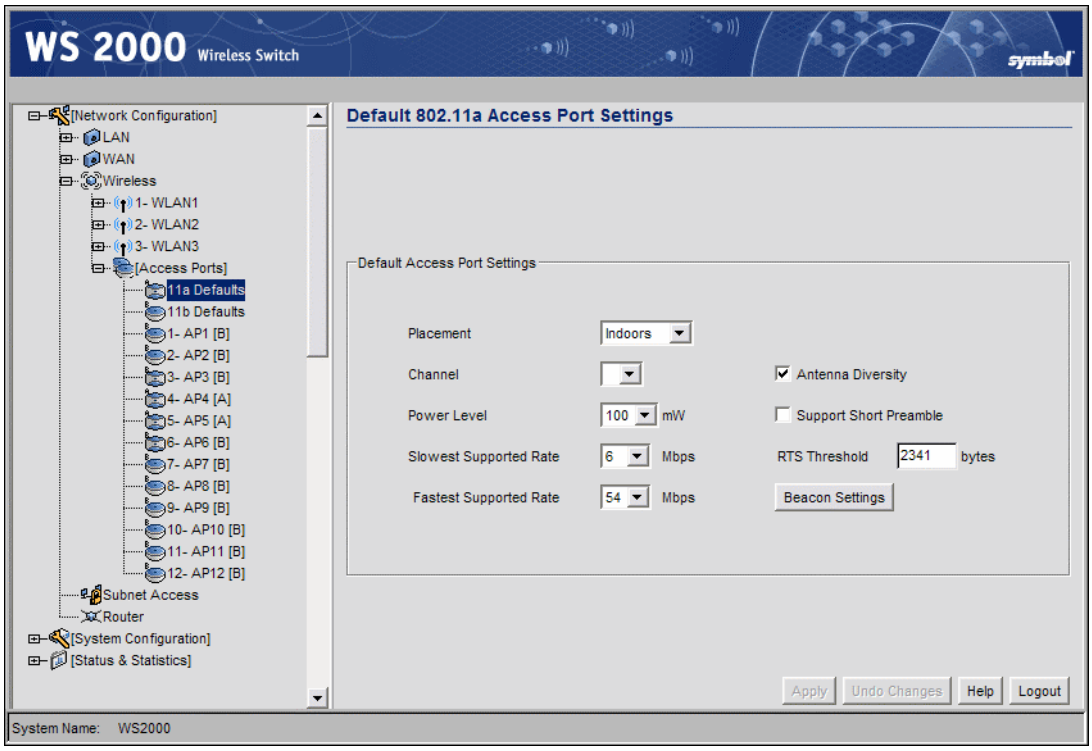


1. Check the **Disallow MU to MU Communications** checkbox to enable a communication block between mobile units (MUs) using this WLAN. Such communication might be a security issue, for example, on a corporate network. Leave this checkbox unchecked (default setting) to allow MU-to-MU communications on this WLAN.
2. Check the **Use Voice Prioritization** checkbox to enable WLAN prioritization of voice over data transmissions. This reduces the latency that might occur when data transmissions and Voice over IP (VoIP) transmissions compete for the same resources. Latency is experienced as broken or delayed speech or sound. Disable this option if VoIP equipment is not in use on this WLAN. The default setting is unchecked.
3. Check the Answer Broadcast ESS checkbox to enable adopted Access Ports to transmit the WLAN's Extended Service Set Identification (ESSID). The purpose of allowing WLANs to answer the broadcast ESS is to identify Access Ports that are associated with the WLAN. This might be appropriate, for example, in a customer environment, such as a "hot spot."
4. Disable this option if broadcasting the WLAN's ESSID poses a security risk, such as on a private, corporate network. The default setting is unchecked.

5. Use the **Multicast Address 1** and **Multicast Address 2** to specify one or two MAC addresses to be used for multicast applications. Some VoIP devices make use of multicast addresses. This mechanism ensures that the multicast packets for these devices are not delayed by the packet queue.
6. Click the **Apply** button to save changes.

WLAN—Setting Default Access Port Settings

The WS 2000 Network Switch can support up to six Access Port. These Access Ports can be either a 802.11a or 802.11b radio type. When an Access Port associates with the wireless switch, the initial settings for that Access Port are taken from the Default Access Port Setting for the appropriate radio type.. Select **Network Configuration** --> **Wireless** --> **Access Ports** --> **Default 802.11 a/b Settings** from the left menu to view and set the default properties for all the two radio types.



Fill out the default information as indicated below:

1. Select either **Indoors** or **Outdoors** from the Placement pop-up menu. This setting will affect the power levels and channels available for selection.
2. Select a channel number from the **Channel** drop-down list on which the Access Port should communicate with associated MUs.

   Note: The available channels vary depending on the location setting of the switch.

3. Select a power level from the **Power Level** drop-down list that will be used for radio communications between the Access Port and the MUs.
4. Select both the **Slowest Supported Rate** and the **Fastest Supported Rate** from the respective drop-down lists to specify the allowable transmission rates for communication between the Access Port and the associated MUs.

5. Check the **Antenna Diversity** checkbox to enable Antenna Diversity if the Access Port has an external antenna. Antenna Diversity should only be enabled if the Access Port has two matching external antennas.
6. Check the **Support Short Preamble** checkbox to allow the Access Port to communicate with the MUs using a short 56-bit preamble.

   A preamble is the beginning part of a frame. The preamble comprises such elements as robust carrier sensing, collision detection, equalizer training, timing recovery, and gain adjustment. The administration can choose between a long or short preamble for data-frame transmission from the WLAN's adopted access ports.

   Use the long preamble setting (the default) for legacy wireless equipment that is not capable of dealing with short preambles. Use the short preamble setting where legacy equipment is not an issue and maximum throughput is desired, for example when streaming video or Voice-over-IP applications are used.
7. Set the Request to Send Threshold (**RTS Threshold**) by specifying a number.

   RTS is a transmitting station's signal that requests a Clear To Send (CTS) response from a receiving station. This RTS/CTS procedure clears the air when many mobile units (MUs) are contending for transmission time. Modifying this value allows the administrator to control the number of data collisions and thereby enhance communication with nodes that are hard to find because of other active nodes in the transmission path.

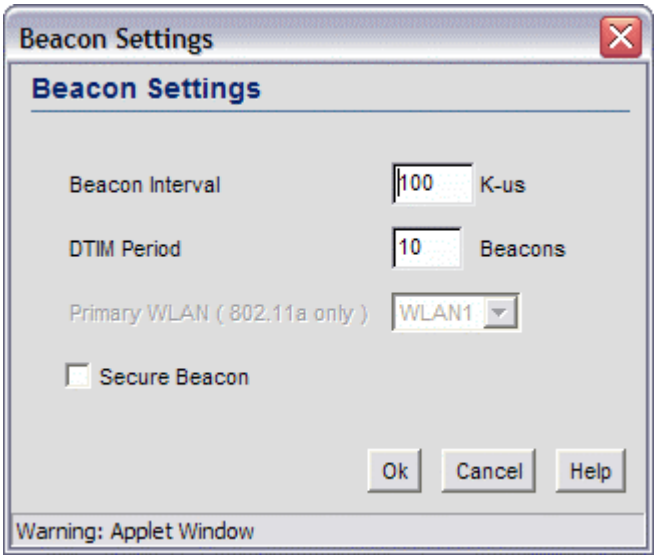
   In this field, the administrator can specify a Request To Send (RTS) threshold (in bytes) for use by the WLAN's adopted access ports.

   This setting initiates an RTS/CTS exchange for data frames that are larger than the threshold, and sends (without RTS/CTS) any data frames that are smaller than the threshold.

   Consider the tradeoffs when setting an appropriate RTS threshold for the WLAN's access ports. A lower RTS threshold causes more frequent RTS/CTS exchanges. This consumes more bandwidth because of the additional latency (RTS/CTS exchanges) before transmissions can commence. A disadvantage is the reduction in data-frame throughput. An advantage is quicker system recovery from electromagnetic interference and data collisions. Environments with more wireless traffic and contention for transmission make the best use of a lower RTS threshold.

   A higher RTS threshold minimizes RTS/CTS exchanges, consuming less bandwidth for data transmissions. A disadvantage is less help to nodes that encounter interference and collisions. An advantage is faster data-frame throughput. Environments with less wireless traffic and contention for transmission make the best use of a higher RTS threshold.

   Set the Access Port beacon settings by clicking on the **Beacon Settings** button. The following window appears.



8. Set the beacon values as indicated in the table below.

Beacon Interval	A beacon is a packet broadcast by the adopted access ports to keep the network synchronized. Included in a beacon is information such as the WLAN service area, the access-port address, the broadcast destination addresses, a time stamp, and indicators about traffic and delivery such as a DTIM. Specify a beacon interval in units of 1,000 microseconds (K-us). This is a multiple of the DTIM value, for example, 100 : 10. Increase the DTIM/beacon settings, lengthening the time, to let nodes sleep longer and preserve their battery life. Decreasing this value (shorten the time) to support streaming-multicast audio and video applications that are jitter-sensitive.
DTIM Period	A DTIM is periodically included in the beacon frame that is transmitted from adopted access ports. The DTIM period determines how often the beacon contains a DTIM, for example, 1 DTIM for every 10 beacons. The DTIM indicates that broadcast and multicast frames, buffered at the access port, are soon to arrive. These are simple data frames that require no acknowledgment, so nodes sometimes miss them. In this field, the administrator can specify a period for the Delivery Traffic Indication Message (DTIM). This is a divisor of the beacon interval (in milliseconds); for example, 10 : 100. Increase the DTIM/beacon settings, lengthening the time, to let nodes sleep longer and preserve their battery life. Decrease this settings (shortening the time) to support streaming-multicast audio and video applications that are jitter-sensitive.

Primary WLAN	Set the **Primary WLAN** field when the 802.11a broadcast protocol is used. When a WLAN is associated with a 801.11a broadcaster only one ESSID can be broadcast from the Access Port (even though three are supported by the switch) . This field specifies which ESSID to broadcast.
Security Beacon	Select the **Security Beacon** checkbox if the WLAN associated with the Access Port needs to be secure. If this feature is selected, the WLAN will not broadcast the ESSID. This selection eliminates the possibility of hackers tapping in to the WLAN without authorization by “stealing” the ESSID.

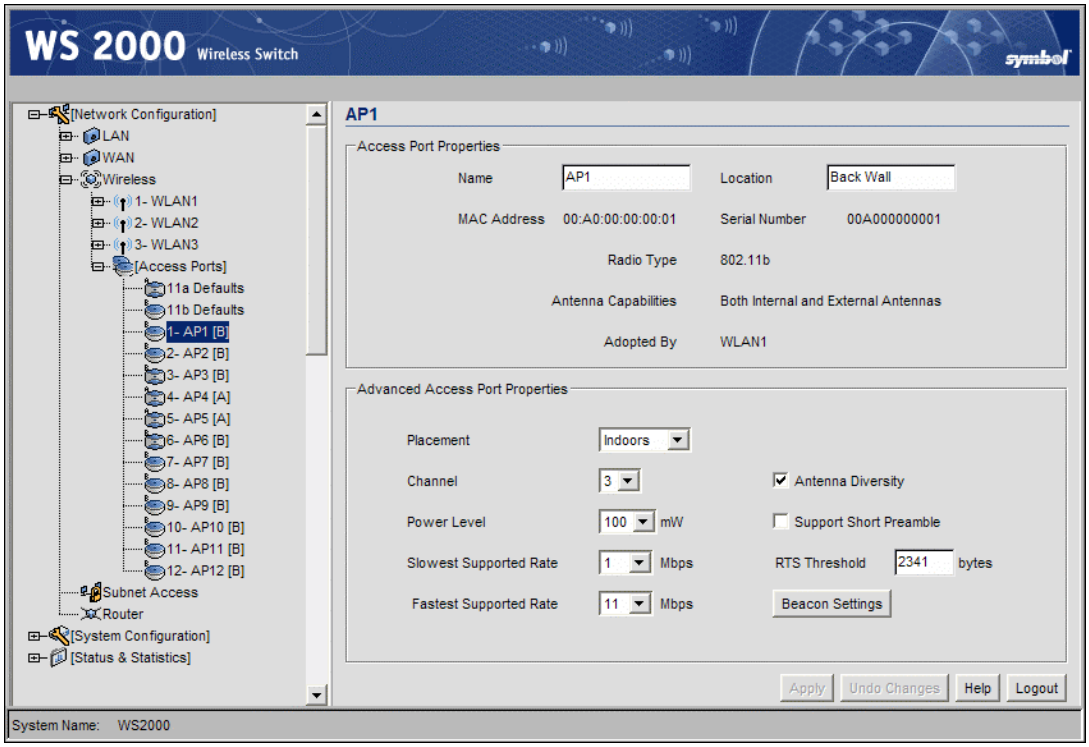
9. Click **OK** when finished setting the beacon settings.
10. Click the **Apply** button to save changes

WLAN—Advanced Access Port Settings

The WS 2000 Wireless Switch GUI allows the administrator to configure the Access Port settings. To examine or change that information:

1. Select **Network Configuration** --> **Wireless** --> **Access Ports** from the left menu and then click the + to the left of the menu item. The detected Access Ports will be listed under the menu item.
2. Select the Access Port to examine or modify.

   When the Access Port Name menu item is selected, the following screen will appear:



The advanced Access Port settings are found at the bottom of the screen. For most installations, the default settings for the advanced settings are appropriate.

1. Select either Indoors or Outdoors from the **Placement** pop-up menu. The setting will affect the selection available for several of the other advanced settings.
2. Select a channel number from the **Channel** drop-down list on which the Access Port should communicate with associated MUs. (The available channels vary depending on the location setting of the switch.)
3. Select a power level from the **Power Level** drop-down list that will be used for radio communications between the Access Port and the MUs.
4. Select both the **Slowest Supported Rate** and the **Fastest Supported Rate** from the respective drop-down lists to specify the allowable transmission rates for communication between the Access Port and the associated MUs.
5. Check the **Antenna Diversity** checkbox to enable Antenna Diversity if the Access Port has an external antenna.
6. Check the **Support Short Preamble** checkbox to allow the Access Port to communicate with the MUs using a short 56-bit preamble.

   A preamble is the beginning part of a frame. The preamble comprises such elements as robust carrier sensing, collision detection, equalizer training, timing recovery, and gain adjustment. The administration can choose between a long or short preamble for data-frame transmission from the WLAN's adopted access ports.

   Use the long preamble setting (the default) for legacy wireless equipment that is not capable of dealing with short preambles. Use the short preamble setting where legacy equipment is not an issue and maximum throughput is desired, for example when streaming video or Voice-over-IP applications are used.
7. Set the Request to Send Threshold (**RTS Threshold**) by specifying a number.

   RTS is a transmitting station's signal that requests a Clear To Send (CTS) response from a receiving station. This RTS/CTS procedure clears the air when many mobile units (MUs) are contending for transmission time. Modifying this value allows the administrator to control the number of data collisions and thereby enhance communication with nodes that are hard to find because of other active nodes in the transmission path.

   In this field, the administrator can specify a Request To Send (RTS) threshold (in bytes) for use by the WLAN's adopted access ports.

   This setting initiates an RTS/CTS exchange for data frames that are larger than the threshold, and sends (without RTS/CTS) any data frames that are smaller than the threshold.

   Consider the tradeoffs when setting an appropriate RTS threshold for the WLAN's access ports. A lower RTS threshold causes more frequent RTS/CTS exchanges. This consumes more bandwidth because of the additional latency (RTS/CTS exchanges) before transmissions can commence. A disadvantage is the reduction in data-frame throughput. An advantage is quicker system recovery from electromagnetic interference and data collisions. Environments with more wireless traffic and contention for transmission make the best use of a lower RTS threshold.

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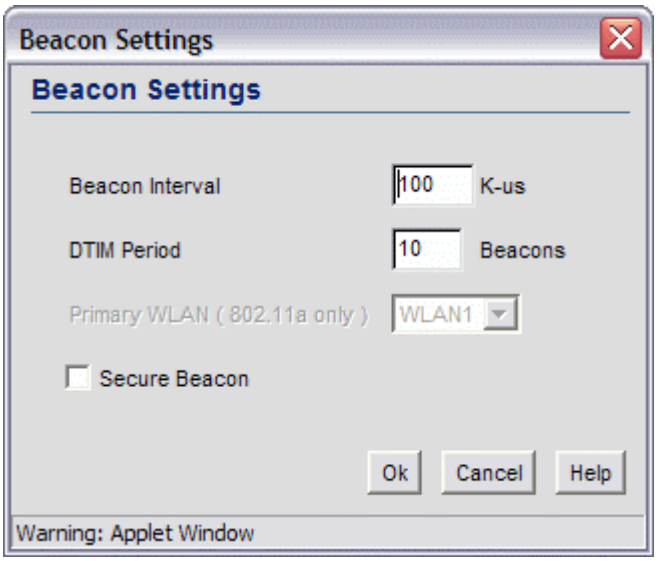

9. Set the beacon values as indicated in the table below.

Beacon Interval	A beacon is a packet broadcast by the adopted access ports to keep the network synchronized. Included in a beacon is information such as the WLAN service area, the access-port address, the broadcast destination addresses, a time stamp, and indicators about traffic and delivery such as a DTIM. Specify a beacon interval in units of 1,000 microseconds (K-us). This is a multiple of the DTIM value, for example, 100 : 10. Increase the DTIM/beacon settings, lengthening the time, to let nodes sleep longer and preserve their battery life. Decreasing this value (shorten the time) to support streaming-multicast audio and video applications that are jitter-sensitive.
DTIM Period	A DTIM is periodically included in the beacon frame that is transmitted from adopted access ports. The DTIM period determines how often the beacon contains a DTIM, for example, 1 DTIM for every 10 beacons. The DTIM indicates that broadcast and multicast frames, buffered at the access port, are soon to arrive. These are simple data frames that require no acknowledgment, so nodes sometimes miss them. In this field, the administrator can specify a period for the Delivery Traffic Indication Message (DTIM). This is a divisor of the beacon interval (in milliseconds); for example, 10 : 100. Increase the DTIM/beacon settings, lengthening the time, to let nodes sleep longer and preserve their battery life. Decrease this settings (shortening the time) to support streaming-multicast audio and video applications that are jitter-sensitive.

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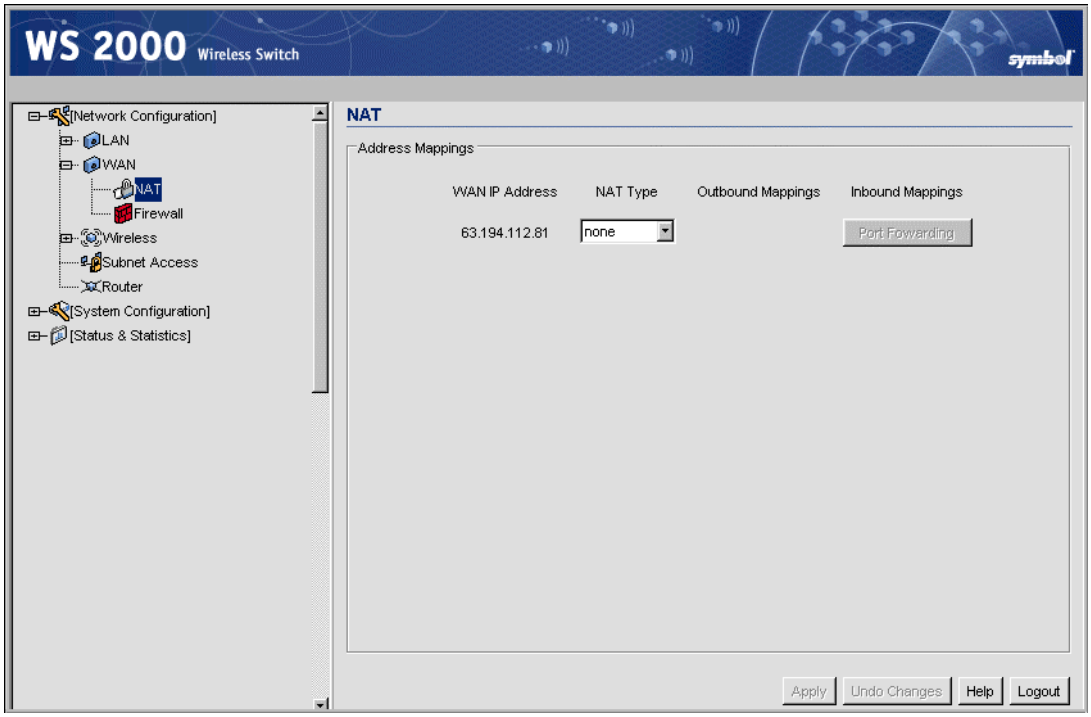
10. Click **OK** when finished setting the beacon settings.
11. Click **Apply** in the Access Port window to save changes.

Gateway—How to Configure Network Address Translation (NAT)

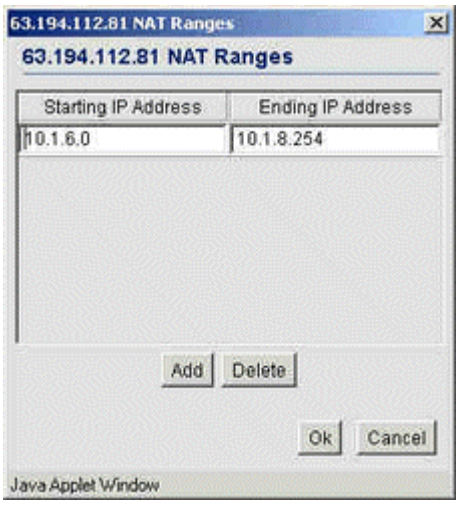
NAT provides the translation of an Internet Protocol (IP) address within one network to a different, known IP address within another network. One network is designated the private network, while the other is the public. NAT provides a layer of security by translating private (local) network addresses to one or more public IP addresses. For example, when an administrator wants to allow individuals on the WAN side access to a particular FTP or web server that is located on one of the LAN subnets but does not want to permit any other access, NAT is the appropriate solution.

1. Select **Network Configuration** --> **WAN** --> **NAT** from the left menu. The following screen appears.



This screen displays the IP addresses specified in the WAN screen (**Network Configuration** --> **WAN** from the left menu). Up to eight WAN addresses can be associated with the switch. The NAT screen enables the administrator to set of the type of translation and port forwarding required.

2. For each of the addresses, the select the NAT type.
   - Select **1 to 1** from the pull-down menu to map a WAN IP address to a single local (subnet) IP address. This selection is useful in situations in which users require dedicated IP addresses or when public-facing servers are connected to the switch.
   - Select **1 to Many** from the pull-down menu to map a WAN IP address to a range of local IP addresses. Use this option when there are fewer public IP address on the WAN than there are users on the LAN. **1 to Many** NAT allows a single IP address to handle traffic from multiple private LAN IP addresses.
   - Select **None** from the pull-down menu when the administrator sets up routable IP addresses (set on the **Network Configuration** --> **Routing** screen).
3. If the NAT type is **1 to 1**, the **Outbound Mappings** field allows the administrator to specify a single IP Address. This address specifies the 1 to 1 mapping between the WAN IP address the specified LAN IP address.
4. If the NAT type is **1 to Many**, the **NAT Ranges** button in the adjacent **Host IP Address** field is active, allowing the administrator to specify a address-range assignment. To set up the ranges click the **NAT Ranges** button.



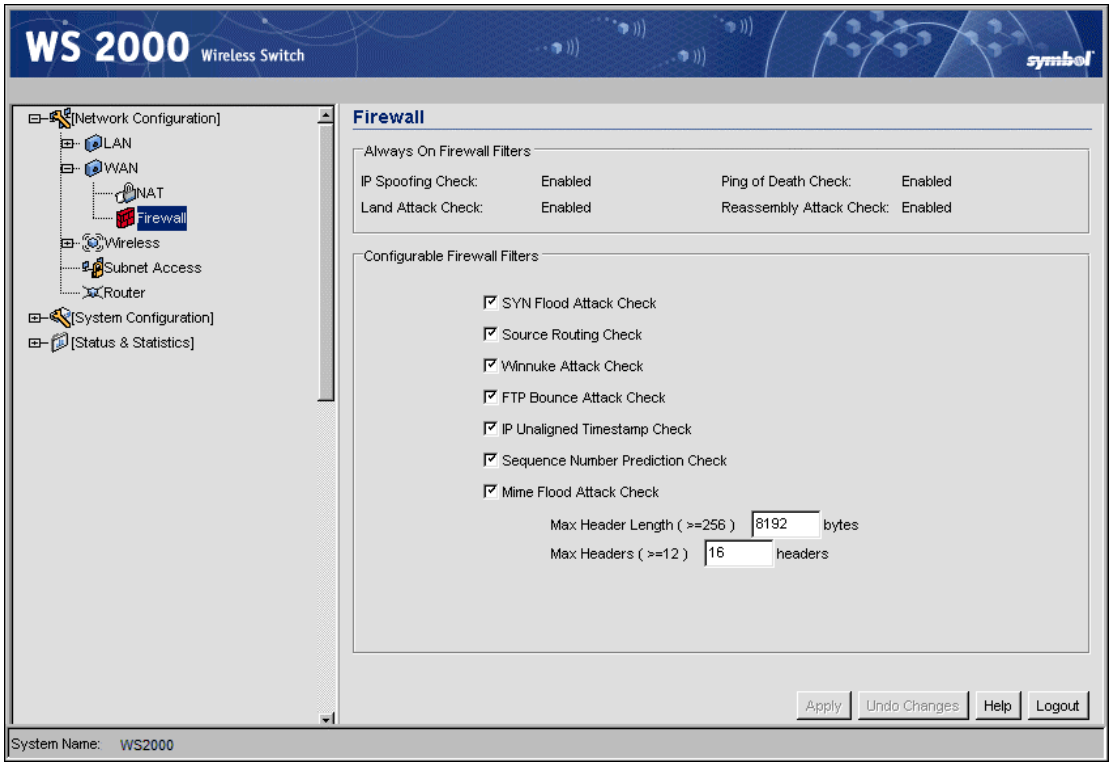
Within the **NAT Ranges** sub-screen, the administrator can specify several IP addresses or IP address ranges. Click the **Add** button to add a new entry. Click the **Delete** button to remove an entry.

5. Click the **Port Forwarding** button to display a sub-screen of port forwarding parameters for inbound traffic from the associated WAN IP address. When finished, click the OK button to close the screen.
6. Click the **Apply** button on the NAT screen to save changes.

Gateway—How to Configure the WS 2000 Firewall

The WS 2000 Wireless Switch provides a secure firewall / Network Address Translation (NAT) solution for the WAN uplink. The firewall includes a proprietary CyberDefense Engine to protect internal networks from known Internet attacks. It also provides additional protection by performing source routing, IP unaligned timestamp, and sequence number prediction. The firewall uses a collection of filters to screen information packets for known types of system attacks. Some of the switch's filters are always enabled, and others are configurable.

To view or change the firewall settings, select **Network Configuration** --> **WAN** --> **Firewall** from the left menu.



Always On Firewall Filters

The filters that are permanently enabled prevent unauthorized and potentially damaging access checks for IP spoofing, land attack, ping of death, and reassembly attack.

- IP spoofing is the creation of TCP/IP packets that illegitimately use (or "spoof") the source IP address of a trusted host when sent.
- A land attack is the creation of a packet that uses the same IP address for both the source-host port and destination-host port when sent.
- The "ping of death" is a type of denial of service attack in which a packet is sent that exceeds the packet size (in bytes) allowed by the IP protocol.
- A reassembly attack uses a reassembly algorithm for sending packets that result in overlapping fragments (overwritten data).

Configurable Firewall Filters

The administrator can enabled or disabled the following filters. By default, all these filters are activated. If it reasonable to turn off the filters if one of the following things is true:

- The switch is on a completely isolated network with no access to the Internet and is therefore secure.
- The switch is heavily loaded a slight increase in performance outweighs the safety of the network.
- Blocking these types of attacks would also block legitimate traffic on their network (although this scenario is highly unlikely.

SYN Flood Attack Check

A SYN flood attack requests a connection and then fails to promptly acknowledge a destination host's response, leaving the destination host vulnerable to a flood of connection requests.

Source Routing Check

A source routing attack specifies an exact route for a packet's travel through a network, while exploiting the use of an intermediate host to gain access to a private host.

Winnuke Attack Check

A "Win-nuking" attack uses the IP address of a destination host to send junk packets to its receiving port. This attack is a type of denial of service (DOS) attack that completely disables networking on systems Microsoft Windows 95 and NT. Because this attack is only affective on older systems, it may not be necessary to enable this feature on a LAN with newer Microsoft Windows operating systems or with systems that have the appropriate "Winnuke" patches loaded.

FTP Bounce Attack Check

An FTP bounce attack uses the PORT command in FTP mode to gain access to arbitrary ports on machines other than the originating client.

IP Unaligned Timestamp Check

An IP unaligned timestamp attack uses a frame with the IP timestamp option, where the timestamp is not aligned on a 32-bit boundary.

Sequence Number Prediction Check

A sequence number prediction attack establishes a three-way TCP connection with a forged source address, and the attacker guesses the sequence number of the destination host's response.

MIME Flood Attack Check

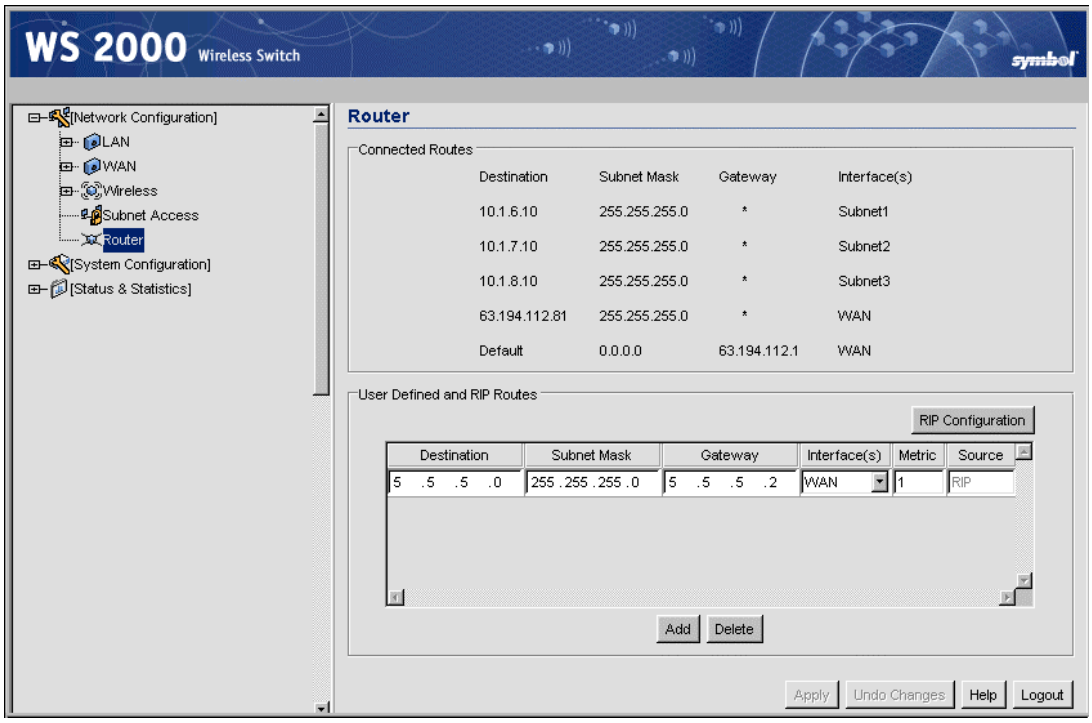
A MIME flood attack uses an improperly formatted MIME header in “sendmail” to cause a buffer overflow on the destination host.

- Use the **Max Header Length** field to set the maximum allowable header length. Set this value to be at least 256 bytes.
- Use the **Max Headers** field to set the maximum number of headers allowed. Set this value to be at least 12.

Click the **Apply** button to save changes made on this screen.

Gateway—How to Configure Static Routes

A router uses routing tables and protocols to forward data packets from one network to another. The switch’s router manages traffic within the switch’s network, and directs traffic from the WAN to destinations on the switch-managed LAN. The WS 2000 Network Management System provides the Router screen to view and set the router’s connected routes. To view this screen, select **Network Configuration** --> **Router** from the menu on the left.



The **Connected Routes** area of the screen displays a list of currently connected routes between the enabled subnets, the WAN, and the router. The information here is generated from settings applied on the Subnet and WAN screens. The destination for each subnet is its IP address. The subnet mask (or network mask) and gateway settings are those belonging to each subnet, or to the WAN in general. If multiple IP addresses are associated with WAN communications, all the address will be displayed in the **Connected Routes** are of the screen. Also listed here is the default route, which specifies the WAN gateway IP address. To make changes to the information in the **Connected Routes** information, go to the appropriate subnet screen (**LAN** --> <subnet name> or the WAN screen (**WAN**).

Defining Routes

The **User Defined and RIP Routes** area of the screen allows the administrator to view, add or delete internal static (dedicated) routes, and to enable or disable routes that are generated using the Routing Information Protocol (RIP). If RIP is enabled, this table can also include routes that RIP generates.

This table also includes internal static routes that the administrator adds. Internal static routes are dedicated routes for data that travels from the WAN, through the switch, and to a specified subnet. Such routes are supplemental to the default routes already set up for each of the subnets.

1. Check the **Enable RIP** checkbox to allow Routing Information Protocol. This is an internal gateway protocol that specifies how routers exchange routing-table information. If this option is enabled, RIP-generated entries appear in the associated table of user-defined and RIP routes.
   Disable this option to prohibit the switch's router from exchanging routing information with other routers. Routing information may not be appropriate to share, for example, if the switch manages a private LAN.
2. Click the **Add** button to create a new table entry.
3. Specify the destination IP address, subnet mask, and gateway information for the internal static route.
4. Select an enabled subnet from the **Interface** column's drop-down menu to complete the table entry.

   Information in the **Metric** column is automatically generated, and is used by router protocols to determine the best hop routes.
5. The Source column automatically displays "User" for a user-added entry. An RIP-sourced entry displays "RIP."
6. Click the **Apply** button to save changes.

Setting the RIP Configuration

The Routing screen also allows the administrator to select the type of RIP and the type of RIP authentication used by the switch. To set or view the RIP configuration, click the **RIP Configuration** button. The following subscreen appears.

1. Set the RIP type from the **RIP Type** drop down menu. The options are:

No RIP	Depending on the **RIP Direction** setting, the **No RIP** option partially or completely disallows the switch's router from exchanging routing information with other routers. Routing information may not be appropriate to share, for example, if the switch manages a private LAN.
RIP v1	RIP version 1 is a mature, stable, and widely supported protocol. It is well suited for use in stub networks and in small autonomous systems that do not have enough redundant paths to warrant the overhead of a more sophisticated protocol.

RIP v2 (v1 compat)	RIP version 2 (compatible with version 1) is an extension of RIP v1's capabilities, but it is still compatible with RIP version 1. RIP version 2 increases the amount of packet information to provide the a simple authentication mechanism to secure table updates.
RIP v2	RIP version 2 enables the use of a simple authentication mechanism to secure table updates. More importantly, RIP version 2 supports subnet masks, a critical feature that is not available in RIP version 1. This selection is not compatible with RIP version 1 support.

2. Select a routing direction from the **RIP Direction** drop-down list. **Both** (for both directions), **Rx only** (receive only) and **TX only** (transmit only) are available options.
3. If **RIP v2** or **RIP v2 (v1 compat)** is the selected RIP type, the **RIP v2 Authentication** area of the screen becomes active. Select the type of authentication to use from the **Authentication Type** drop-down list. Available options are:

None	This option disables the RIP authentication.
Simple	This option enable RIP version 2's simple authentication mechanism. This setting activates the **Password (Simple Authentication)** field.
MD5	This option enables the MD5 algorithm for data verification. MD5 takes as input a message of arbitrary length and produces a 128-bit fingerprint. The MD5 algorithm is intended for digital signature applications, in which a large file must be compressed in a secure manner before being encrypted with a private (secret) key under a public-key cryptographic system. The MD5 setting activates the **RIP v2 Authentication** settings for keys (below).

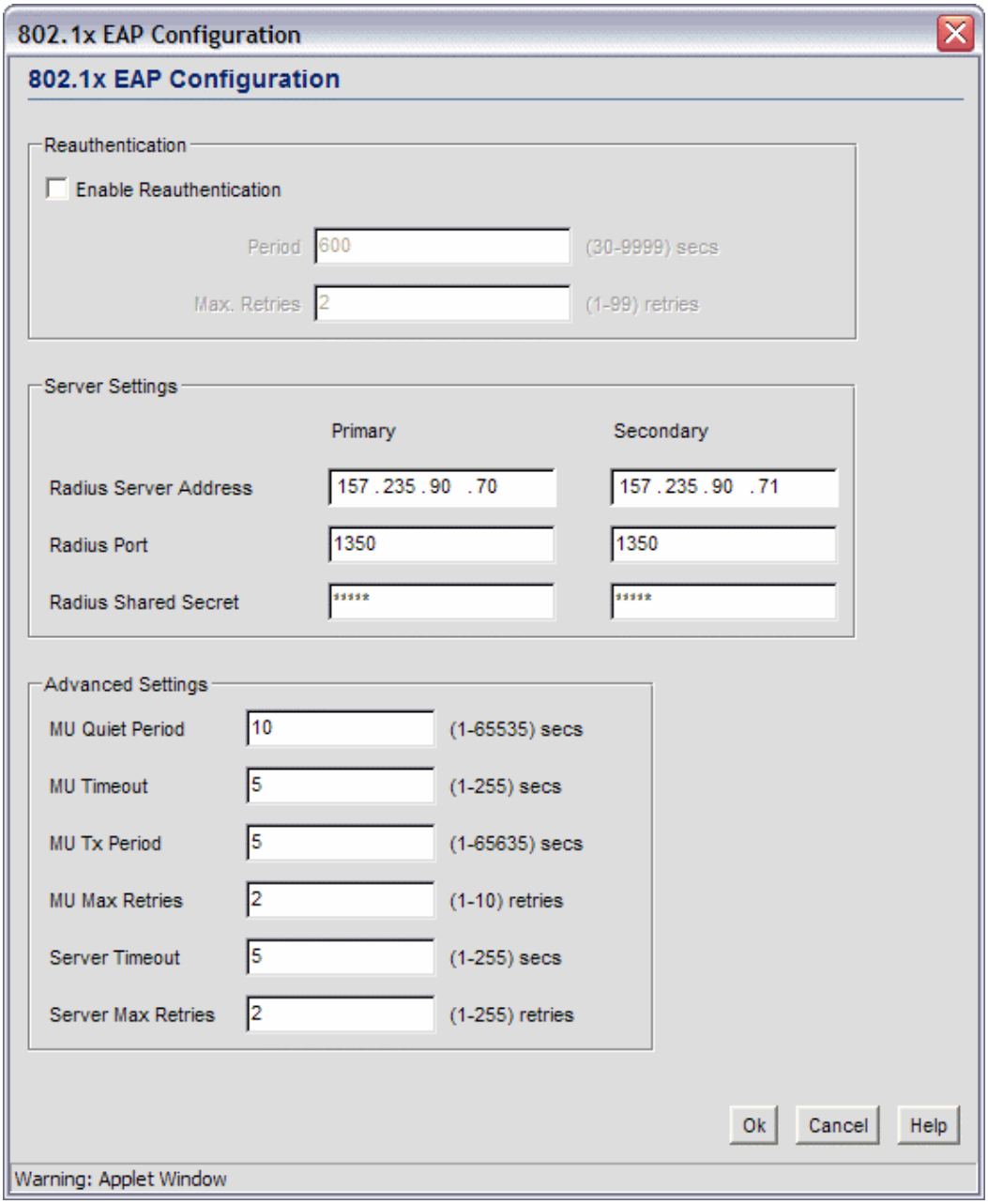
4. If the Simple authentication method is selected, specify a password of up to 15 alphanumeric characters in the **Password (Simple Authentication)** field.
5. If the MD5 authentication method is selected, fill in the **Key #1** and **Key #2** fields. Type in any numeric value between 0 and 256 into the **MD5 ID** field. Type in any string consisting of 16 alphanumeric characters into the **MD5 Auth Key** field.
6. Click the **OK** button to return to the Routing screen.

Security—How to Configure 802.1x EAP Authentication

The IEEE 802.1x is an authentication standard that ties EAP to both wired and wireless LAN applications. EAP provides effective authentication with or without IEEE 802.1x Wired Equivalent Privacy (WEP) encryption, or with no encryption at all. EAP supports multiple authentication measures. It requires that the site have a authentication (Remote Dial-In User Service—RADIUS) server on the wired side of the Access Port. All other packet types are blocked until the authentication server verifies the client's identity. To set up 802.1x EAP authentication:

1. Go to the **Network Configuration** --> **Wireless** --> <WLAN Name> --> <WLAN Name> **Security** screen.
2. Select the **802.1x EAP** radio button to enable the 802.1x Extensible Authentication Protocol (EAP).

3. Click the **802.1x EAP Configuration** button to display a sub-screen for specific authentication settings.



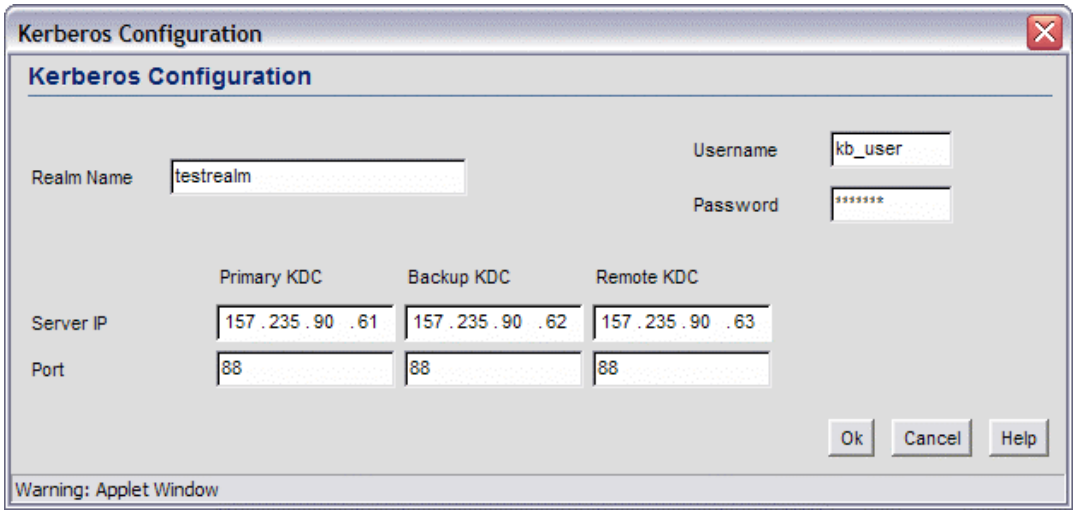
4. Check the **Enable Reauthentication** check box to enable this authentication method.
5. Set the EAP reauthentication period to match the appropriate level of security. A shorter time interval (~ 30 seconds or longer) provides tighter security on this WLAN's wireless connections. A longer interval (5000-9999 seconds) relaxes security on wireless connections. The reauthentication period setting does not affect a wireless connection's throughput. The engaged access port continues to forward traffic during the reauthentication process.

6. Set the maximum number of retries (**Max. Retries**) for a client to successfully reauthenticate after failing to complete the EAP process. If the mobile unit fails the authentication process in specified number of retries, the switch will terminate the connection to the mobile unit.
7. The administrator is required to specify the **IP address** of a primary RADIUS server for this type of authentication to work. Providing the IP address of a secondary server is optional. The secondary server acts as a failover server if the switch cannot successfully contact the primary server.
8. Specify the port on which the primary RADIUS server is listening in the **Radius port** field. Optionally, specify the port of a secondary (failover) server. Older RADIUS servers listen on ports 1645 and 1646. Newer servers listen on ports 1812 and 1813. Port 1645 or 1812 is used for authentication. Port 1646 or 1813 is used for accounting. The ISP or a network administrator can confirm the appropriate primary and secondary port numbers.
9. The administrator can specify a **Radius shared secret** for authentication on the primary RADIUS server. Shared secrets are used to verify that RADIUS messages, with the exception of the Access-Request message, are sent by a RADIUS-enabled device that is configured with the same shared secret. The shared secret is a case-sensitive string that can have letters, numbers, or symbols. Make the shared secret at least 22 characters long to protect the RADIUS server from brute-force attacks.
10. The **MU Quiet Period** field allows the administrator to specify the idle time (in seconds) between a mobile unit's authentication attempts, as required by the server.
11. The **MU Timeout** allows the administrator to specify the time (in seconds) for the mobile unit's retransmission of EAP-Request packets.
12. The **MU Tx Period** field allows the administrator to specify the time period (in seconds) for the server's retransmission of the EAP-Request/Identity frame.
13. The **MU Max Retries** field allows the administrator to set the maximum number of times for the mobile unit to retransmit an EAP-Request frame to the server before it times out the authentication session. Note that this is a different value from the **Max Retry** field at the top of the window.
14. The **Server Timeout** indicates the maximum time (in seconds) that the switch will wait for the server's transmission of EAP Transmit packets.
15. The **Server Max Retries** field allows the administrator to set the maximum number of times for the server to retransmit an EAP-Request frame to the client before it times out the authentication session. Note that this is a different value from the **Max Retry** field at the top of the window.
16. Click the **Apply** button to save changes.

Security—How to Configure Kerberos Authentication

Kerberos provides strong authentication method for client/server applications by using secret-key cryptography. Using this protocol, a client can prove its identity to a server (and vice versa) across an insecure network connection. After a client and server use Kerberos to prove their identity, they can encrypt all communications to assure privacy and data integrity.

1. Select the **Kerberos** radio button to enable Kerberos authentication.
2. Click the **Kerberos Configuration** button to display a sub-screen for authentication settings.



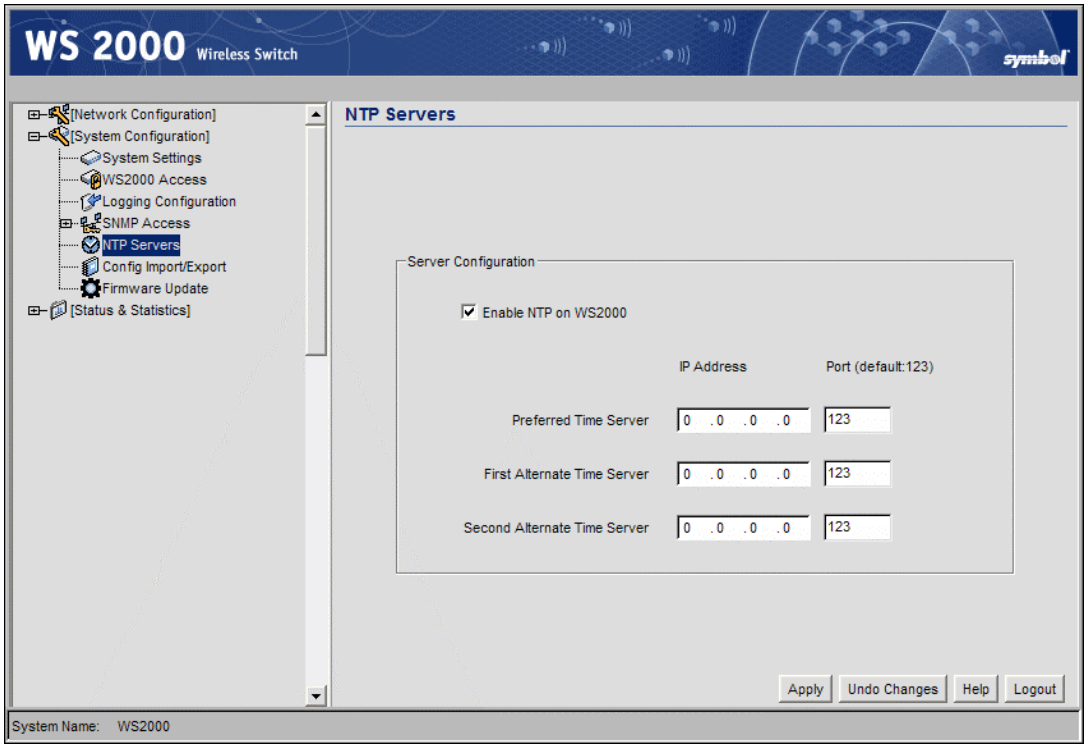
3. A realm name functions similarly to a DNS domain name. In theory, the realm name is arbitrary; however, in practice a Kerberos realm is typically named using an uppercase version of the DNS domain name that is associated with hosts in the realm. Specify a realm name that is case-sensitive, for example, MYCOMPANY.COM.
4. Specify a **Username** for the Kerberos configuration.
5. Specify a **Password** for the Kerberos configuration.

   The KDC (Key Distribution Center) implements an Authentication Service and a ticket granting service, whereby an authorized user is granted a ticket that is encrypted with the user's password. The KDC has a copy of every user password.
6. Specify a server IP address and a port to be used as the **Primary KDC**.
7. Optionally, specify a **Backup KDC** server by providing the IP address and port.
8. Optionally, specify a **Remote KDC** server by providing the IP address and port.
9. Click **OK** when done.

Security—How to Specify a Network Time Protocol (NTP) Server

Network Time Protocol (NTP) manages time and clock synchronization in a network environment. The switch, which acts as an NTP client, periodically synchronizes its clock with a master clock on an NTP server. Time synchronization is typically optional (although recommended) for the switch's network operations; however, for sites using Kerberos authentication, time synchronization is required. Kerberos must synchronize the clocks of its Key Distribution Center (KDC) server(s).

1. Select **System Configuration** --> **NTP Servers** from the left menu to enable NTP. The NTP Server screen appears.



2. Select **Enable NTP on WS2000** to enable NTP service.
3. Specify a **Preferred Time Server**, and optionally a **First Alternate Time Server** and a **Second Alternate Time Server** by specifying the **IP address** and **Port** for the time service for each server. The default port is 123. The larger number of NTP servers specified, provides the greatest assurance of uninterrupted time synchronization.
4. Click the **Apply** button to save any changes made on this screen. Navigating away from the current screen without clicking the **Apply** button will result in the loss of all changes to this screen.

Chapter 5. System Administration

Overview

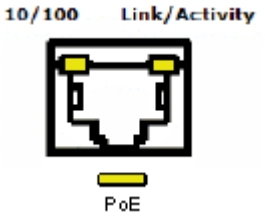
The WS 2000 Network Management System provides several screens for administering the switch and monitoring activity on the switch. From the interface the administrator can:

- Change the general system settings, such as the name of the switch and the location of the switch
- Export or import the switch's configuration settings
- Find and install firmware updates
- Change the settings for who can access the switch for administration purposes
- Configure how log files are saved
- View system statistics for WAN communication, the subnets, and for the associated Access Ports

Switch Settings

WS 2000 Wireless Switch LED Functions

Each port on the Wireless Switch has either two or three LEDs that indicate the status of the port. Ports 1-4, which supply 802.3af Power over Ethernet (PoE), have three LEDs. The remaining two non-powered LAN ports and the WAN port have two LEDs.



Location	Description
Upper left LED	This LED is present on all ports and indicates the speed of the transmissions through the port. The LED is on when the transmission rate is 100 Mbits per second (100BaseT). The light is off when the transmission rate is 10 Mbits per second.
Upper right LED	This LED indicates activity on the port. This light is solid yellow when a link to a device is made. The light flashes when traffic is being transferred over the line.

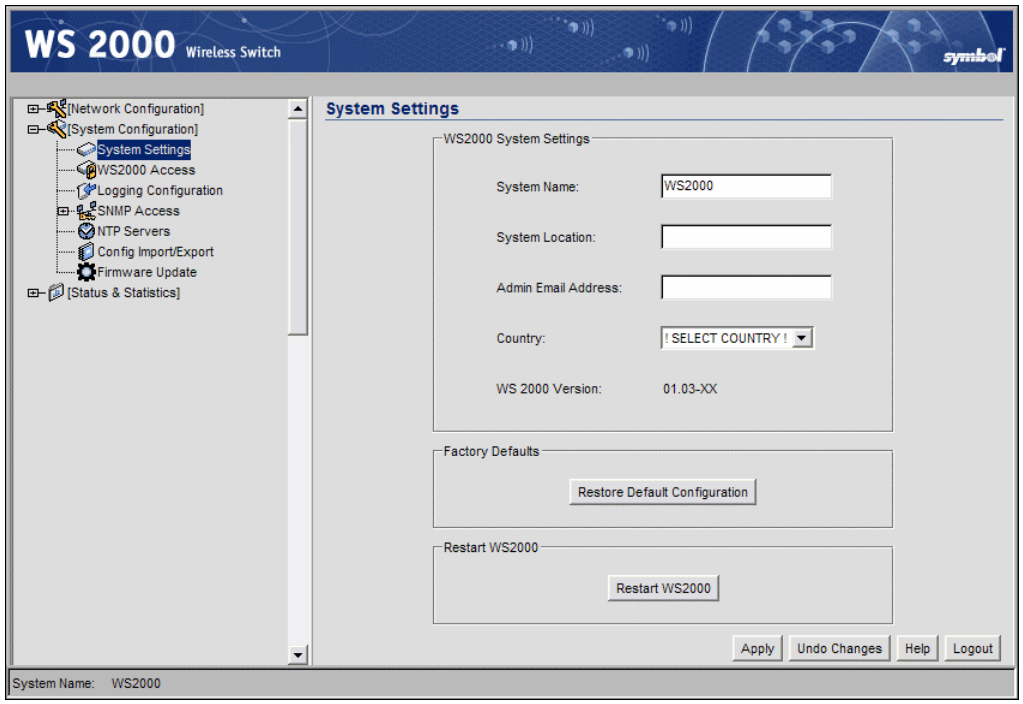
Location	Description
Lower LED	This LED is only present on Ports 1-4. These ports provide 802.3af Power over Ethernet (PoE) support to devices (such as Access Ports). The LED has several states: • OFF — A non-power device (or no device) is connected; no power is being delivered • GREEN — The switch is delivering 48 volts to the power device connected to that port. • RED — There was a valid PoE connection; however, the switch has detected that the power device is faulty. The red light will remain until a non-faulty connection is made to the port

Changing the Name of the Switch

When the administrator first logs into the WS 2000 Network Management System, the **System Settings** screen appears. One of the fields in this screen is the **System Name** field. In this field, the administrator can specify the name of the switch. This name is used to distinguish the switch from others that are on the network and it is also used to set the device name in SNMP.

To examine and change the current name for the switch:

1. Select **System Configuration** --> **System Settings** from the left menu.



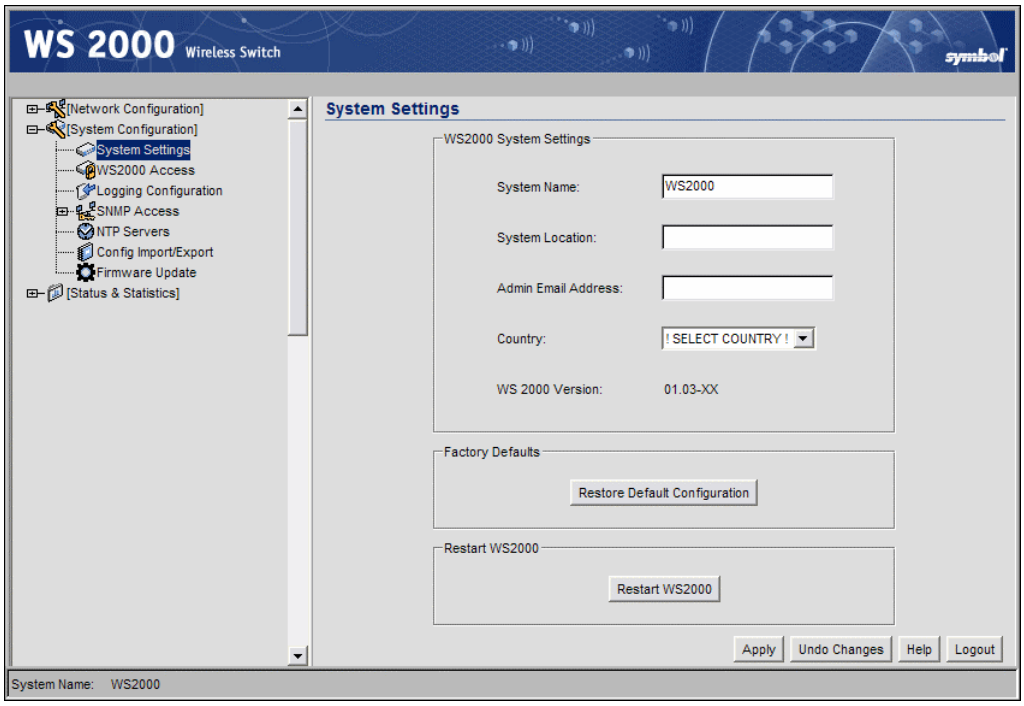
2. Find the **System Name** field and type a string of alphanumeric characters to create a name.
3. Select the **Apply** button to save the change.

Change the Location and Country Settings of the WS 2000

When the administrator first logs into the WS 2000 Network Management System, the **System Settings** screen appears. One of the fields in this screen is the **Country** field. This field is set to the country in which the switch is installed. Setting this field appropriately ensures compliance with national and local laws concerning electromagnetic emissions and the power level of Access Port radio transmissions.

To examine and change the location setting for the switch:

1. Select **System Configuration** --> **System Settings** from the left menu.

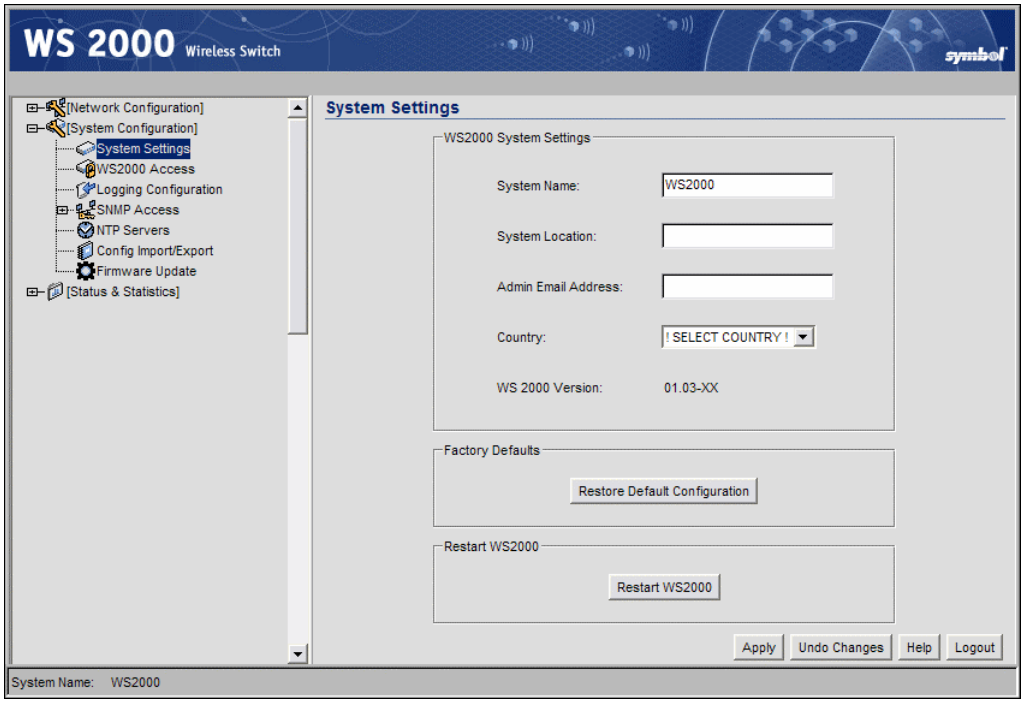


2. Type in a description of the physical location of the switch within your facility into the **Location** field.
3. Find the **Country** field and use the drop down menu to select the correct country from the list.
4. Click **Apply** to save changes. The interface will ask you to confirm any changes you make to the **Country** selection.

How to Restart the WS 2000 Wireless Switch

During the normal course of operations, the administrator might need to restart or reset the switch. For example, changing certain configuration settings can require restarting the switch for those settings to take effect.

1. Select **System Configuration** --> **System Settings** from the left menu.



2. Click the **Restart WS 2000** button to restart the switch. A second window appears, asking for confirmation.
3. Select the **Restart** button. Upon confirming the restart, the switch reboots. Typically, normal communications with the switch are restored within a minute or two.

Note: Configuration settings are unaffected by the restart process; however, all cumulative transmission and reception statistics are reset to zero.

Updating the WS 2000 Wireless Switch's Firmware

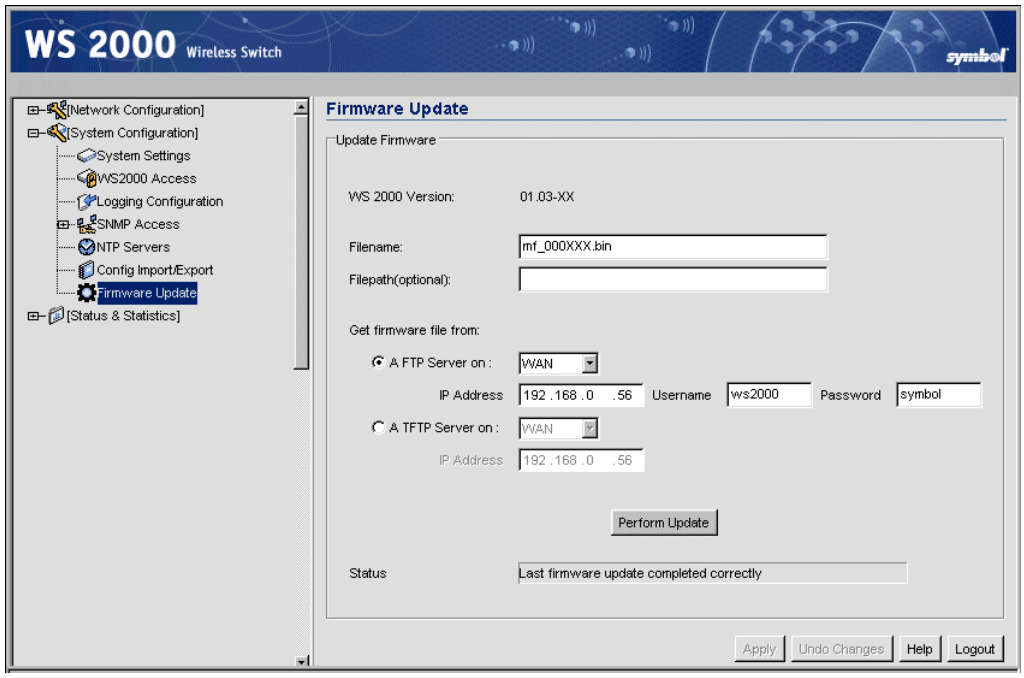
From time to time, Symbol will release updates to the WS 2000 Wireless Switch's firmware. These updates will include:

- Information about how to communicate with newly released Access Ports
- Updates for security issues that have been identified
- Fixes to any software problems that have been identified

Checking for and Downloading Firmware updates

The switch administrator should check for firmware updates for the WS 2000 Wireless Switch on a monthly basis, as follows:

1. Select **System Configuration** --> **Firmware Update** or **Network Configuration** --> **System Settings** from the left menu.



2. Examine the **WS 2000 Version** field to record the version number of the currently loaded software. It should be something like 1.02-10.
3. Go to the web site http://www.symbol.com/services/downloads/ and select the link to the WS 2000 Wireless Switch.
4. Compare the WS 2000 Version with the most recent version listed on the site. All updates will be listed along with a description of what the update contains.
5. Check to see if an administrator has already downloaded the file. It might already be on an FTP server at the site. If not, download the update from http://www.symbol.com/services/downloads/.

Performing the Firmware Update

To perform the update, the update file must be available from an FTP or TFTP site. The administrator supplies the site information and the WS 2000 Network Management System will perform FTP/TFTP and the update for the administrator.

1. Save the WS 2000 Network Switch's current configuration settings (**System Configuration** --> **Config Import/Export**)
2. Select **System Configuration** --> **Firmware Update** from the left menu to view the Firmware Update screen.
3. Specify the name of the update file (such as WS_22343.bin).
4. Specify a folder pathname to the FTP login, if necessary.
5. Select either the **FTP** or **TFTP** radio button, as appropriate.

6. Specify whether the site is on the WAN or is on one of the subnets associated with the switch by selecting the appropriate choice from the drop-down menu to the right of the radio button.
7. Specify the **IP address** or domain name of the system that has the update file.
8. Specify a **Username** and **Password** that will allow the FTP login and access to the file.
9. Click the **Perform Update** button to initiate the firmware update for the switch.
10. After the switch reboots, return to the **Firmware Update** screen. Read the **Status** field to verify that the firmware update completed successfully.
11. Confirm that the wireless switch's configuration settings are the same as prior to the update. If not, restore the settings. See "Exporting and Importing Wireless Switch Settings."

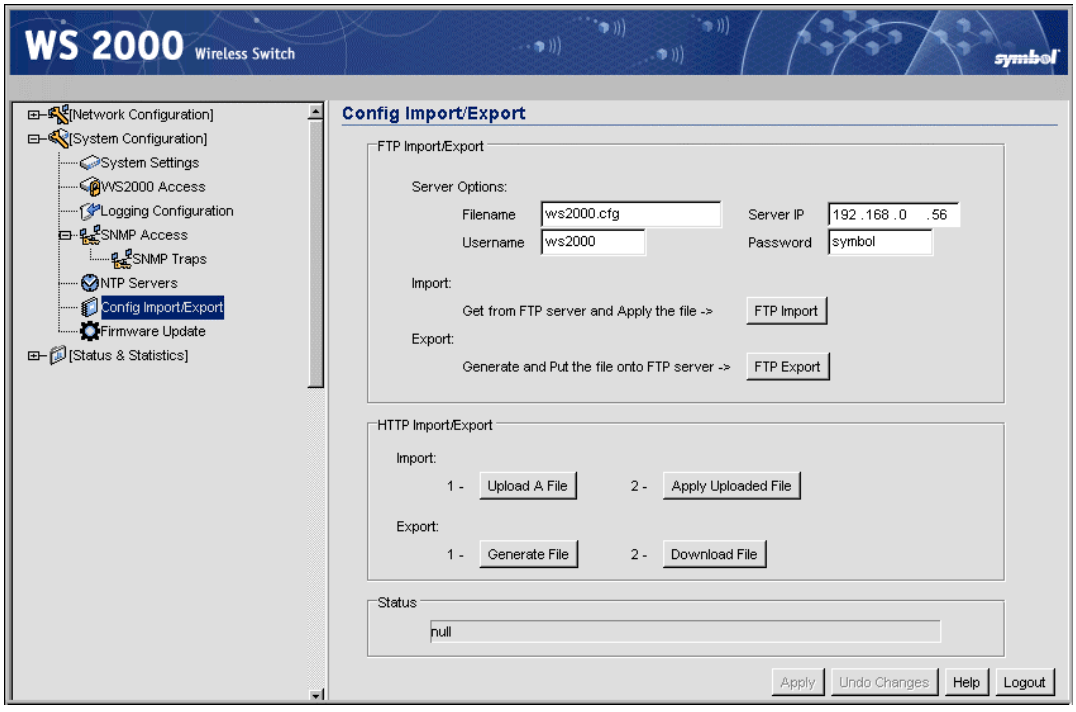
System Configuration

Exporting and Importing Wireless Switch Settings

All of the configuration settings for the WS 2000 Wireless Switch can be saved to a configuration file and then either imported back into the same switch or transferred to another switch. This file-based configuration saving feature provides several benefits:

- It can speed the switch setup process significantly at sites using multiple WS 2000 Wireless switches
- It allows an administrator to "backup" the current switch configuration before making significant changes, before restoring the default configuration, or for precautionary measures.

Select **System Configuration** --> **Config Import/Export** from the left menu to import or export the switch configuration settings.



To Import or Export Settings to an FTP Site

Use the following procedure for exporting the switch's configuration settings.

1. Specify the name of the log **Filename** to be written to or read from the FTP server.
2. Specify the **Server IP** address of the FTP server to which the log file will be imported or exported.
3. Specify the **Username** to be used when logging in to the FTP server. The user account must be established on the FTP server that is targeted for importing or exporting file data.
4. Specify the **Password** that will allow the user access to the FTP server for the import or export operation.
5. Click the **FTP Import** button to import a configuration file from the FTP server with the given filename and login information. The system will display a confirmation window indicating that the administrator must log out of the switch after the operation completes for the changes to take effect.

   Click the **FTP Export** button to export the configuration to a file on the FTP server with the given filename and login information.
6. After executing the export, check the **Status** field for messages about the success or errors in executing the specified operation.

To Import Settings to a Local File

1. Click the **Upload A File** button in the HTTP Import/Export area to specify a configuration file name that can be specified within the file system.
2. Type in the name of the file, or use the **Browse** button to find and select the file to import.
3. Once the upload is successful, click the **Apply Uploaded File** button to apply the new configuration to the switch. Check the **Status** area in the lower portion of the window for any errors generated during the import process.

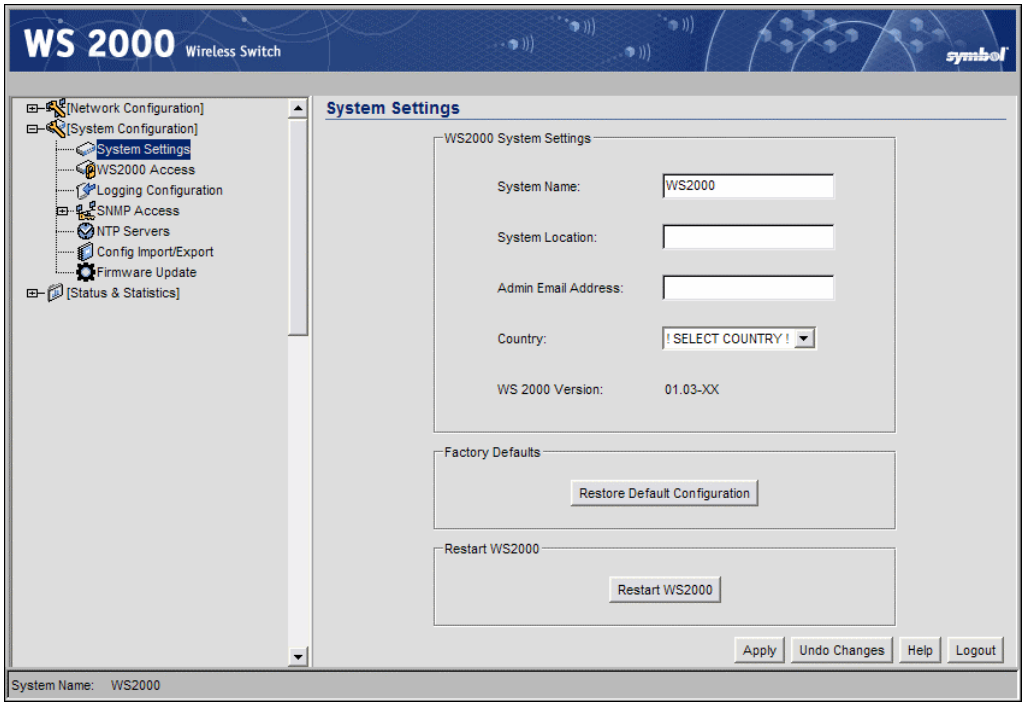
To Export Settings to a Local File

1. Click the **Generate File** button in the HTTP Import/Export area to specify a name for the configuration file.
2. Type in the name of the file. Use the **Browse** button to navigate to the desired directory.
3. Once the name is accepted, click the **Download File** button to write the configuration settings to the file.
4. After executing the export, check the **Status** field for messages about the success or errors in executing the specified operation.

How to Restore Default Configuration Settings

Although it should not be necessary during the normal course of operations, the administrator might need to return to the default configuration settings of the switch. To do so, see the directions below:

1. Consider saving the current configuration settings. See “Exporting and Importing Wireless Switch Settings” for directions on how to save the settings.
2. Select **System Configuration** --> **System Settings** from the left menu.



3. Click the **Restore Default Configuration** button to restore all factory settings. The system will display a warning that current settings be lost and ask for confirmation that the action should be taken.
4. Click the **Yes** button. Upon confirming the restoration of default settings, the switch reboots.
5. After the reboot is complete, log into the switch’s configuration screen using “**admin**” for the user ID and “**symbol**” for the password.

If, for some reason, access to the user interface is not possible to restore the factory settings, a process for restoring the defaults from the command line interface is available.

Restoring Default Configuration Settings Using the Command Line Interface

Although it should not be necessary during the normal course of operations, the administrator might need to restore the default configuration settings of the switch. This procedure is typically performed from the WS 2000 Network Management System user interface; however, there are circumstances in which the administrator cannot access the switch through the user interface (for example, if the administrator accidentally disables all the subnet checkboxes in the WS2000 Access screen). Because of this, there is a process for restoring the defaults from the command line interface. Follow the directions below.

1. Using a null-modem cable, attach a computer or terminal to the DB-9 serial port on the front of the switch for direct access to the command-line interface.
2. Using a terminal emulation program, such as HyperTerminal, set up a connection to the switch through the COM port that is connected to the null-modem cable.
3. Set the properties for the port as indicated below.

Property	**Value**
Bits per second:	19,200
Data bits:	8
Parity:	None
Stop bits:	1
Flow control:	None

4. When the communications program initiates the connection with the switch, a prompt to enter manager's password is displayed. Type in the manager password and then the ENTER key.
5. When the prompt is displayed type "**admin**" and ENTER. The interface with then prompt you for the current admin password. Type in the password and then the ENTER key. If the login is successful, a prompt is displayed.
6. Type the command "**system**" followed by the ENTER key.
7. Type the command "**config**" followed by the ENTER key.
8. Type the command "**default**" followed by the ENTER key. The default configuration settings will be restored and the switch will reboot.

After the reboot is complete, you can log into the switch with the standard user interface. The default IP address for the switch is 192.168. 0.1, and the login information is "**admin**" for the user ID and "**symbol**" is the password.

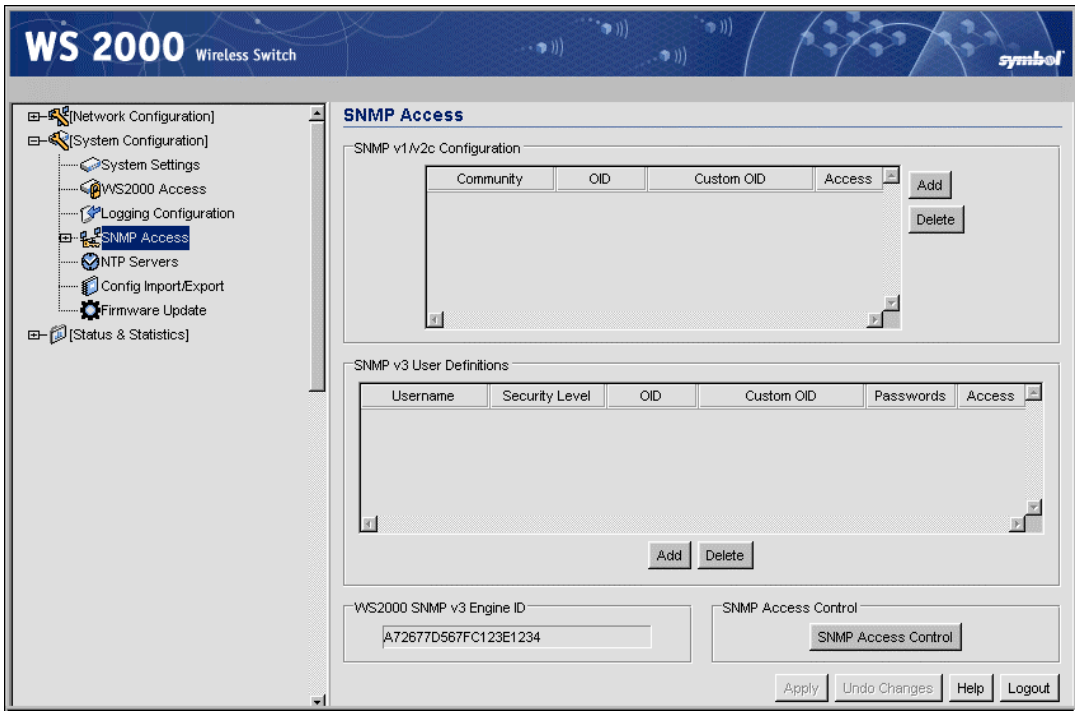
See Appendix A for a sample configuration file.

Remote Administration

How to Configure SNMP Traps

The Simple Network Management Protocol (SNMP) facilitates the exchange of management information between network devices. SNMP allows an administrator to manage network performance, find and solve network problems, and plan for network growth. The WS 2000 Wireless Switch includes SNMP management functions for gathering information from its network components, and communicating that information to specific users. For more background about SNMP, see SNMP Management Support.

Select **System Configuration** --> **SNMP Access** from the left menu to set up SNMP service.



Setting the SNMP Version Configuration

The SNMP Access screen allows the administrator to define SNMP v1/v2c community definitions and SNMP v3 user definitions. SNMP v1 and v2c provide a strong network management system, but their security is relatively weak. SNMP v3 provides greatly enhanced security protocols. SNMP v3 encrypts transmissions and provides authentication for users generating requests.

Setting Up SNMP v1/v2c Community Definitions

SNMP v1/v2c community definitions allow read-only or read/write access to switch-management information, as appropriate. The SNMP community, in this case, includes users whose IP addresses are specified on the SNMP Access Control subscreen. A read-only community string allows a remote device to retrieve information, while a read/write community string also allows a remote device to modify settings. Set up a read/write definition to facilitate full access by the administrator.

1. To create a new community definition, click the **Add** button in the **SNMP v1/v2c Community Configuration** area.
2. Specify a site-appropriate name for the community.
3. Use the **OID** (Object Identifier) pull-down list to select either **All** or **Custom**. If **All** is selection, the community has access to all the OIDs (SNMP parameters) in the SNMP Management Information Base (MIB) file. If **Custom** is selected, the administrator can allow access to specific OIDs in the MIB to certain communities.
4. If **Custom** is selected in the OLD field, type in an OID number into the **Custom OID** field. The format is in a numerical dot notation, and valid numbers can be found within the MIB.
5. Use the **Access** pull-down list to specify read-only (**R**) access or read/write (**RW**) access for the community. Read-only access allows a remote device to retrieve switch information, while read/write access also allows a remote device to modify switch settings.
6. Follow the directions for setting up the Access Control List (below).

Setting Up SNMP v3 Community Definitions

Setting up the v3 user definition is very similar to the v1/v2c community definitions. The difference is the addition of a user security level and a user password.

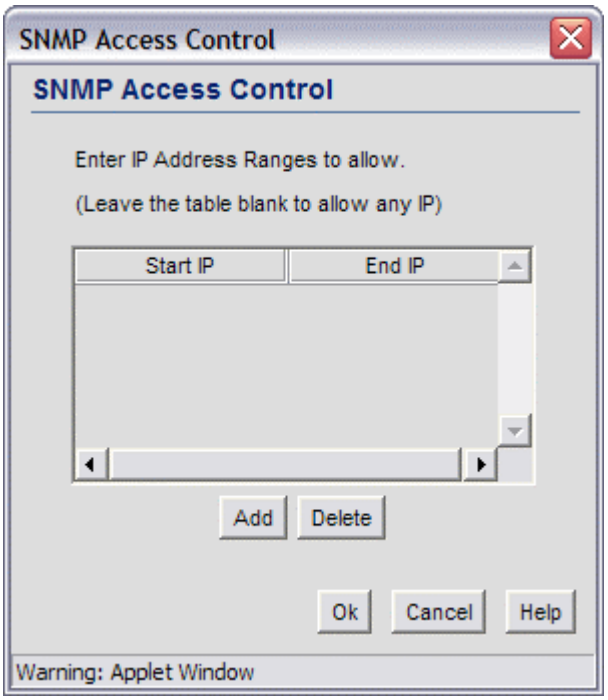
1. To create a new SNMP v3 user definition, click the **Add** button in the **SNMP v3 User Definitions** area.
2. Specify a user name in the **Username** field.
3. Select a security level from the **Security** pull-down list. Select from the following choices:

noAuth	(no authorization) Allows the user to access SNMP without authorization or encryption
AuthNoPriv	(authorization without privacy) Requires the user to login, however no encryption is used
AuthPriv	(authorization with privacy) Requires the user to login and encryption is used

4. Use the **OID** (Object Identifier) pull-down list to select either **All** or **Custom**. If **All** is selection, the community has access to all the OIDs (SNMP parameters) in the MIB file. If **Custom** is selected, the administrator can allow access to specific OIDs in the MIB to certain communities.
5. If **Custom** is selected in the OLD field, type in an OID number into the **Custom OID** field. The format is in a numerical dot notation, and valid numbers can be found within the MIB.
6. Specify a password (up to 11 characters) for the user when logging in.
7. Use the **Access** pull-down list to specify read-only (**R**) access or read/write (**RW**) access for the community. Read-only access allows a remote device to retrieve switch information, while read/write access also allows a remote device to modify switch settings.
8. Follow the directions for setting up the Access Control List (below).

Setting Up the Access Control List

To set up the Access Control list as specified by a range of IP addresses, click the **SNMP Access Control** button at the bottom of the **SNMP Access** screen. The SNMP Access Control screen appears:



1. Click the **Add** button to create a new entry in the Access Control table.
2. Specify the IP address for the user(s) that have access. Enter an IP address only in the **Starting IP Address** column to specify an address for a single SNMP user. Enter both the **Starting IP Address** and **Ending IP Address** columns to specify a range of addresses for SNMP users.
3. Click **OK** to save changes and return to the **SNMP Access** screen.

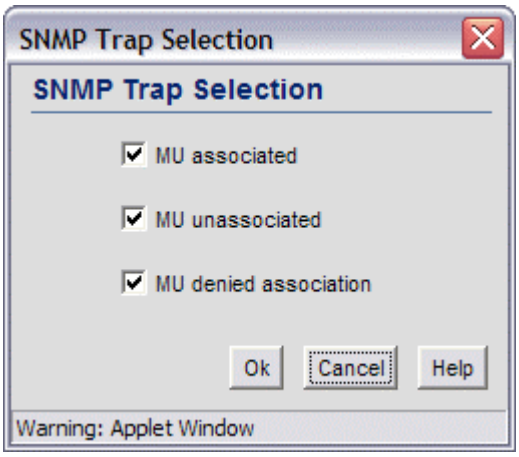
Setting the Trap Configuration

The final step in setting up SNMP is to specify the types of network events that generate traps, and who to notify regarding the events. SNMP traps are generated according to predefined types of network events that are considered important to manage. This information is asynchronously reported to the switch's SNMP network-management system by switch-managed entities. Notification is sent to the responsible individuals whose IP addresses are listed for trap notification.

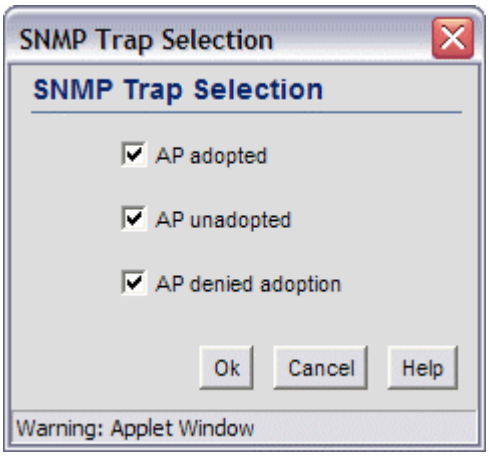
1. To set the SNMP traps, select **System Configuration** --> **SNMP Access** --> **SNMP Traps** from the left menu.
2. Select the type of traps that will generate notification events. To do this, click each of the four trap buttons in the SNMP Trap Selection area to see all the possible trap settings.

SNMP Traps

MU Traps



AP Traps



3. Check the traps to enable.

Trap Category	Trap Name	Generates a Trap when…
SNMP Traps	**Cold Start**	The switch's router reinitializes while transmitting, possibly altering the agent's configuration or protocol entity implementation.
	SNMP ACL violation	An SNMP client cannot access SNMP management functions or data due to an Access Control List (ACL) violation.
	SNMP authentication failures	An SNMP-capable client is denied access to the switch's SNMP management functions or data. This may result from incorrect login.
	Configuration Changes	Check this box to generate a trap when the SNMP access or management functions are reconfigured.

Trap Category	Trap Name	Generates a Trap when…
MU Traps	**MU associated**	An MU becomes associated with one of the switch's Wireless Local Area Networks (WLANs).
	MU unassociated	An MU becomes unassociated with (or gets dropped from) one of the switch's WLANs.
	MU denied association	Check this box to generate a trap when an MU cannot associate with the switch-managed network. A denial of service can result from an absent or incorrectly specified MAC address on a WLAN Security screen.
AP Traps	**AP adopted**	Any of the switch's Wireless Local Area Networks (WLANs) adopts an AP.
	AP unadopted	Any of the switch's WLANs unadopts (or drops) an AP.
	AP denied adoption	Check this box to generate a trap when any of the switch's WLANs deny the adoption of an AP.

4. Click the **OK** button when done setting traps in a subwindow.
5. Click the **Apply** button to save the trap settings.
6. It is necessary to tell the switch where to send the notifications. Set the trap configuration (directions found in one of the following two sections) to indicate where to send the notifications.

Setting the Trap Configuration for SNMP v1/v2c

To set the trap notification destination for the SNMP v1/v2c servers, add one or more entries to SNMP v1/v2c Trap Configuration table.

1. Click the **Add** button to add a new entry to the table.
2. Specify a **Destination IP** addresses for the systems that will receive notification when an SNMP trap is generated.
3. Specify a destination User Datagram Protocol (UDP) port for receiving the traps that are sent by SNMP agents.
   UDP offers direct connection for sending and receiving datagrams over an IP network.
4. Specify a **Community** name that matches one of the community names added on the SNMP Access screen.
5. Select the appropriate **SNMP Version** (v1 or v2) from the pull-down list for this particular SNMP server.
6. Click the **Apply** button to save the entries.

Setting the Trap Configuration for SNMP V3

To set the trap notification destination for the SNMP v3 servers, add one or more entries to SNMP v3 Trap Configuration table.

1. Click the **Add** button to add a new entry to the table.
2. Specify a **Destination IP** addresses for the systems that will receive notification when an SNMP trap is generated.
3. Specify a destination User Datagram Protocol (UDP) port for receiving the traps that are sent by SNMP agents.
   UDP offers direct connection for sending and receiving datagrams over an IP network.
4. Specify a **Username** that matches one of the user names added on the SNMP Access screen.
5. Specify a Security level to **noAuth** (no authorization required), **AuthNoPriv** (authorization without encryption), or **AuthPriv** (authorization with encryption).
6. Specify a password for the user.

***Warning**: When entering the same username on the SNMP Traps and SNMP Access screens, the password entered on the SNMP Traps page will overwrite the password entered on the SNMP Access page. To avoid this problem enter the same password on both pages.*

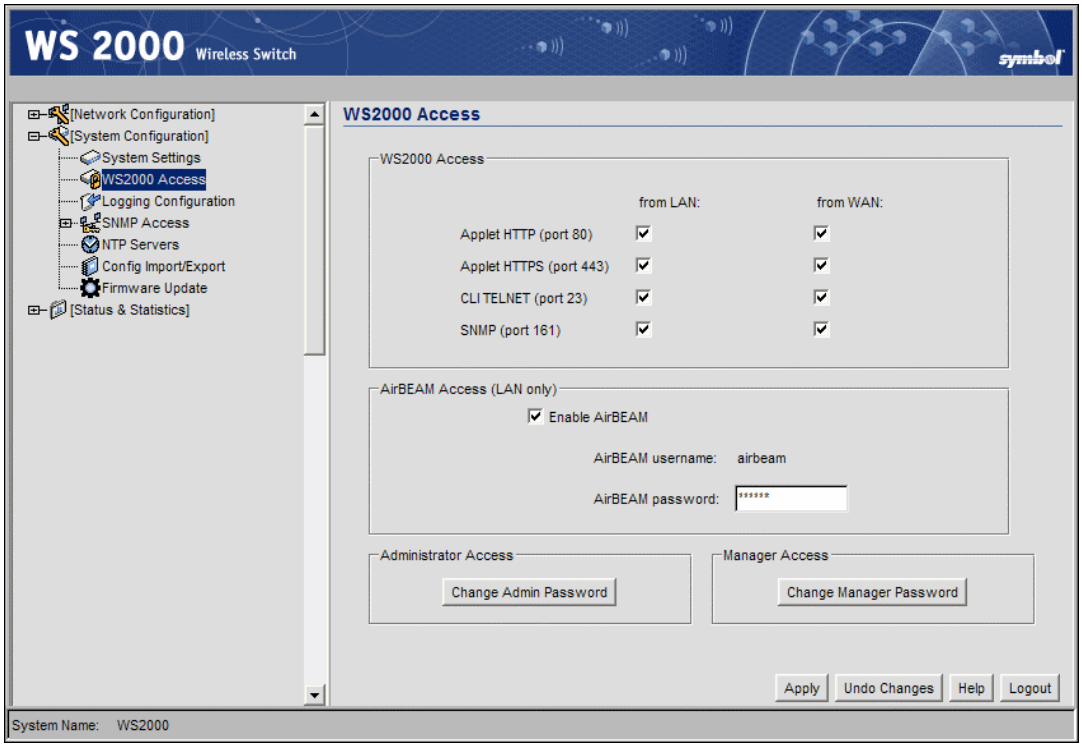
Configure Administrator Access

The WS 2000 Network Management System allows two different users to log in to perform administration tasks: the switch administrator and the manager.

The switch administrator can change any settings within the WS 2000 Network Management System. The default login name for the switch administrator is "**admin**" and the initial password is "**symbol**".

The manager can only view switch statistic (select **Statistics & Status**). The login name of the manager is "**manager**" and the initial password is "**symbol**".

To configure which interfaces the administrators can access the user interface or to change the passwords of the administrators, select **System Configuration** --> **WS 2000 Access** from the left menu.



Configure Management Access

The WS 2000 Network Management System runs from a standard Web browser. Any individual on an enabled subnet or over the WAN can access the log screen by specifying one of the IP addresses associated with the user interface. The **WS 2000 Access** screen allows the administrator to restrict access from different locations. By selecting the appropriate checkboxes, the administrator can allow or disallow specific types of access from the WAN port or from the LAN subnets.

Choose the types of access to allow by checking the associated checkbox.

Access	Port	Description
Applet HTTP	80	Allows access to the WS 2000 Management System through a standard http web browser communication.
Applet HTTP	443	Allows access to the WS 2000 Management System through a https (secure) connection from a web browser.
CLI TELNET	23	Allows administration access to the wireless switch through TELNET. Allows the user to access the switch through the command line interface.
SNMP	161	Allows administration access for an SNMP server.

Note: If all the checkboxes in this section are disabled, the administrator will not be able to access the switch through the WS2000 Management System user interface. The only access available is through a direct serial cable connection from a PC. All commands are given using the command line interface. If this situation occurs accidentally, you can restore the switch's factory settings using the command line interface.

Setup AirBEAM Software Access

Symbol's AirBEAM software suite is a comprehensive set of mobility management tools that maximize the availability, security and effectiveness of a wireless network. The fields in this section of the screen allow the administrator to enable access from the AirBEAM software suite and to set the AirBEAM password.

1. To enable AirBEAM access, check the **Enable AirBEAM** checkbox.
2. Specify a password for AirBEAM software access. Note that the AirBEAM login name is always "airbeam".
3. Click the **Apply** button to save changes.

Changing the Administrator and Manager Passwords

In the lower half of the WS 2000 Access screen, two buttons open sub-screens that allow the administrator to change either the switch administrator's or switch manager's passwords. For reasons of security, the administrator should change both passwords to something other than the default, before the system becomes operational.

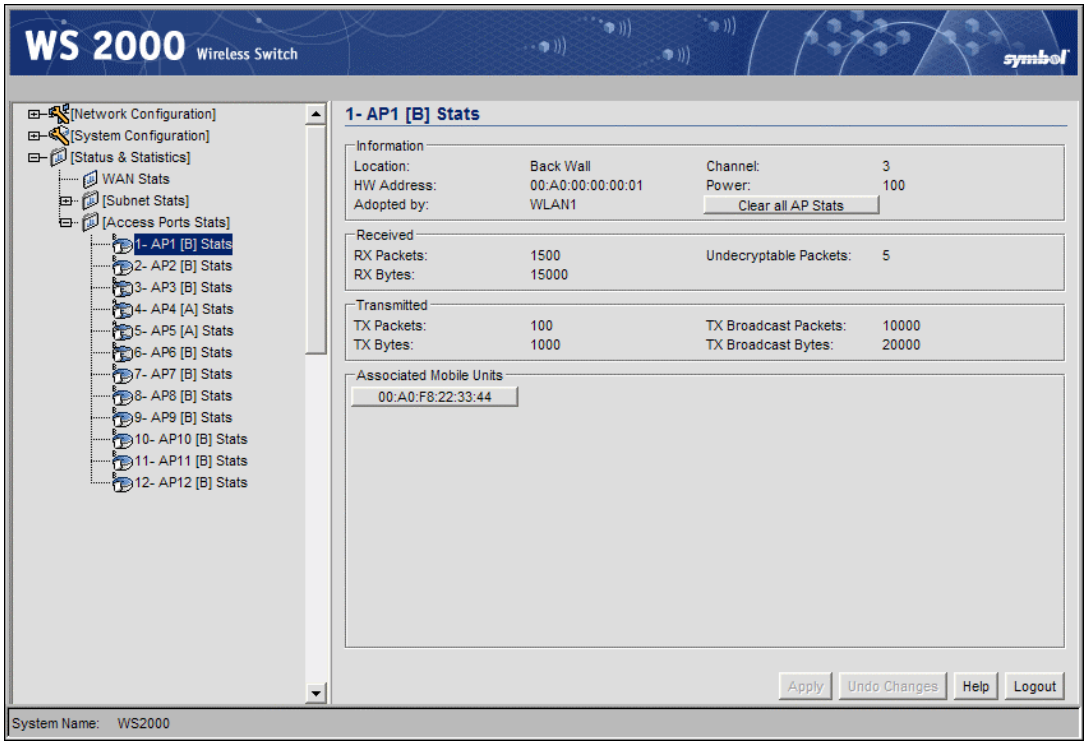
- Select **Change Admin Password** to open the screen to change the switch administrator's password. Type in the current administrator password and the new password twice.
- Select **Change Manager Password** to open the screen to change the manager's password. Type in the current administrator password and the new manager passwords twice.

  Note: If the administrator does not remember the current password, the administrator can contact Symbol Technical Support for directions on how to proceed.

Statistics and Logs

Access Port Statistics

The WS 2000 Network Management System provides a screen that displays basic access port information, as well as real-time statistics about the activity on each Access Port and its associated units. To see statistics about a particular Access Port, select **Status & Statistics** --> **Access Port** --> <Access Port Name> from the left menu.



There are four areas on the screen. The **Information** area shows general information about the Access Port. The **Received** and **Transmitted** areas of the screen display statistics for the cumulative packets, bytes, and errors received and transmitted through the Access Port. The Associated Mobile Units section lists the MUs and provides information on specific MUs that are currently transmitting through the Access Port.

General Access Port Information

Information Field	Description
Location	The site location of the Access Port (an optional field that the administrator fills in on the **Wireless** --> **Access Ports** --> <Access Port Name> screen).
HW Address	The Media Access Control (MAC) address of the Access Port. This value is typically set at the factory and can be found on the bottom of the Access Port.
Adopted by	The WLANs that currently adopt this access port (see **Network Configuration** --> **Wireless** for the Access Port Adoption List)
Channel	This field indicates the channel for communications between the Access Port and mobile units. To specify the value, go to the corresponding Access Port screen.
Power	The power level in milliwatts (mW) for RF signal strength is specified on the corresponding Access Port screen.

Click on the **Clear all AP Stats** button to clear all the statistics for the selected Access Port.

Received and Transmitted Tables

The **Received** and **Transmitted** areas of the screen display statistics for the cumulative Access Port statistics, **since the Access Port was last adopted or the switch was last rebooted**.

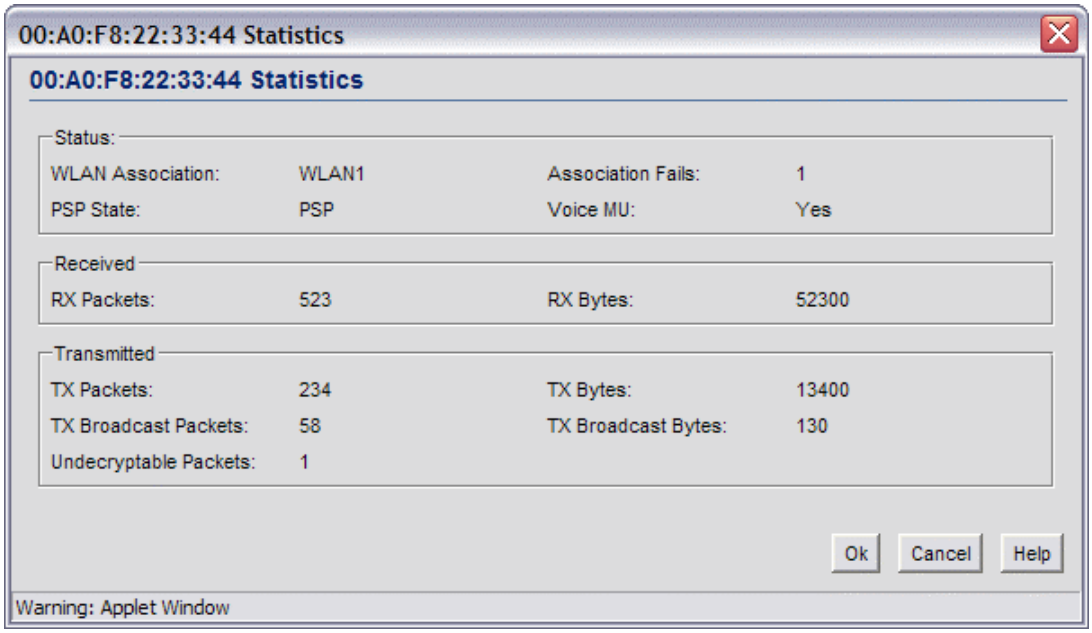
Received Field	Description
RX Packets	Total number of data packets received by the Access Port
RX Bytes	Total number of bytes of information received by the Access Port
Undecryptable Packets	Total number of data packets that cannot be read due to data corruption, lack of a proper encryption handshake, and so on

Transmit Field	Description
TX Packets	Total number of data packets sent by the Access Port
TX Bytes	Total number of bytes of information sent by the Access Port
TX Broadcast Packets	Total number of broadcast packets sent by the Access Port.
TX Broadcast Bytes	Total number of broadcast bytes sent by the Access Port.

Associated Mobile Units

Each Access Port can have up to 32 associated mobile units. These units are listed in the Mobile Unit Access Control List of the WLAN Security screen (**Network Configuration** --> **Wireless** --> <WLAN Name> --> <WLAN Name> **Security**.

To see statistics about a particular mobile unit, click the **MAC address** button for the mobile unit. A sub-screen appears.

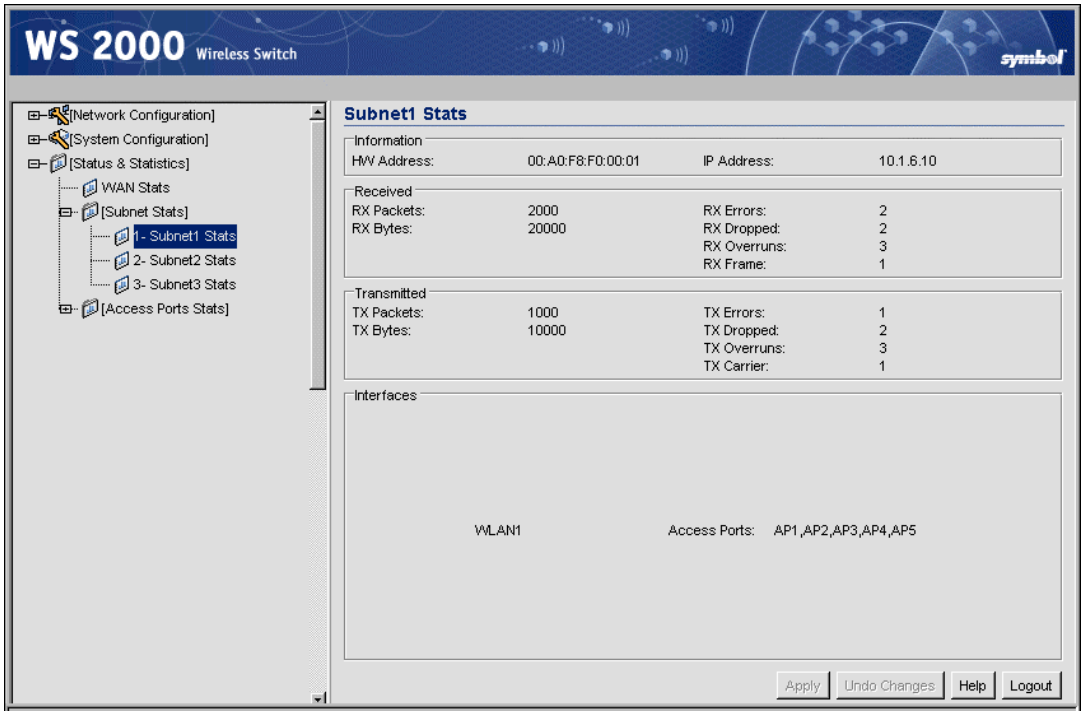


The **Received** and **Transmitted** portions of the screen display statistics for the cumulative packets, bytes, and errors received and transmitted through the access port for the associated mobile unit **since it last gained access to the switch-managed network**.

Field	Description
WLAN Association	Indicates the WLAN that is associated with the mobile unit.
PSP Mode	Under normal circumstances a switch will terminate a connection with a mobile unit if it doesn't exchange packets regularly. Many laptops that shut down their NIC when there is no network activity. The switch stops seeing the MU and cuts the connection. When PSP is enabled, the MU can stop communication with the switch and the connection will remain active. When the MU starts communicating to the Access Port again the connection does not need to be reestablished.
Association Fails	The total number of attempts that the Access Port has made to associate with the mobile unit which have failed.
Voice MU	Indicate whether the mobile unit is a voice-based Mobile unit or not. The value is yes, if the MY is a voice-based
RX Packets	Total number of data packets received by the Access Port from the mobile unit
RX Bytes	Total number of bytes of information received by the Access Port from the mobile unit
TX Packets	Total number of data packets sent by the Access Port to the mobile unit
TX Broadcast Packets	Total number of broadcast packets sent by the Access Port to the associated mobile unit
TX Bytes	Total number of bytes sent by the Access Port to the associated mobile unit
TX Broadcast Bytes	Total number of bytes broadcast by the Access Port to the associated mobile unit
Undecryptable Packets	Total number of bytes that could not be decrypted.

Subnet Statistics

The WS 2000 Network Management System provides a set of screens that allow the administrator to view real-time statistics for monitoring the switch's activity. One of those screens displays statistics for each of the subnets. Selecting **Status & Statistics** --> **Subnet Stats** --> <Subnet Name> **Stats** from the left menu displays the following screen.



The **Information** portion of the **Subnet Stats** screen displays general information about the subnet.

- The **HW address** is the Media Access Control (MAC) address of the switch's WAN port, which is set at the factory.
- The IP addresses displayed here for the subnet connection are set on the subnet screen (**Network Configuration** --> **WLAN** --> <subnet name>).

The **Received** and **Transmitted** portions of the screen display statistics for the cumulative packets, bytes, and errors received and transmitted through the WAN interface **since the WAN was last enabled or the switch was last rebooted**.

Received Field	Description
RX Packets	The total number of data packets received over the subnet
RX Bytes	The total number of bytes of information received over the subnet
RX Errors	The total number of errors including dropped data packets, buffer overruns, and frame errors on inbound traffic
RX Dropped	The number of data packets that failed to reach the subnet
RX Overruns	The total number of buffer overruns (when packets are received faster than the subnet can handle them)
RX Frame	The total number of TCP/IP data frame errors received

Transmitted Field	Description
TX Packets	The total number of data packets sent over the subnet
TX Bytes	The total number of bytes of information sent over the subnet

Transmitted Field	Description
TX Errors	The total number of errors including dropped data packets, buffer overruns, and carrier errors that fail on outbound traffic
TX Dropped	The number of data packets that fail to get sent from the subnet
TX Overruns	The total number of buffer overruns (when packets are sent faster than the subnet can handle them)
TX Carrier	The total number of TCP/IP data carrier errors received

Interfaces

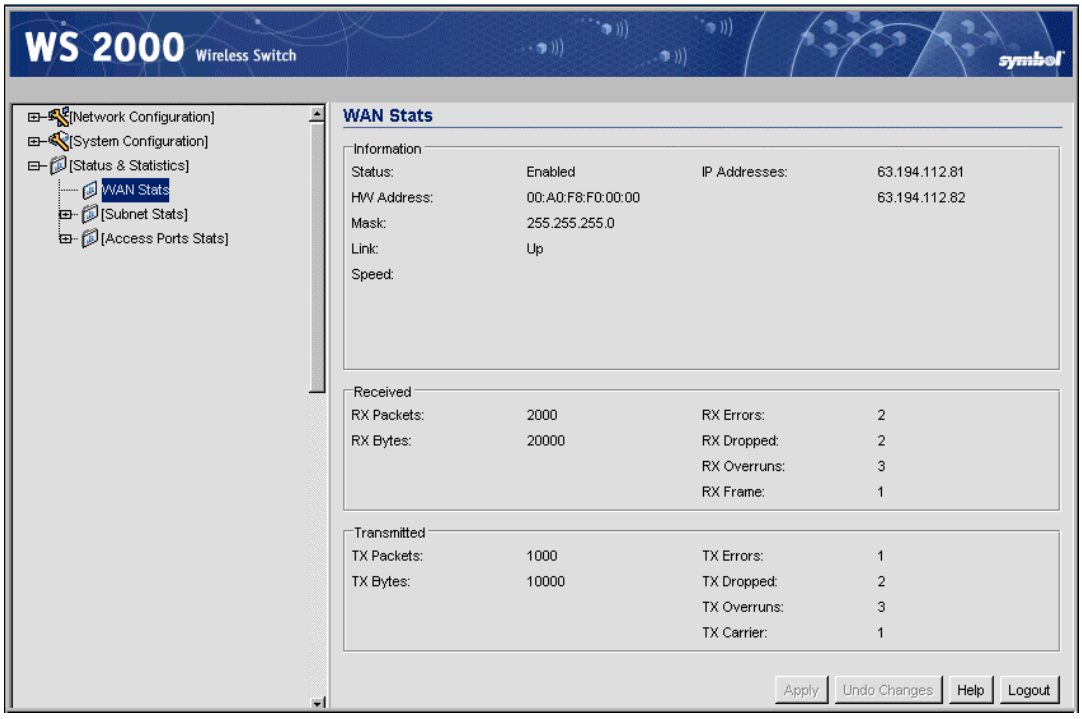
The interfaces section of the screen displays information about the ports and Access Ports associated with the subnet (set in **Network Configuration** --> **Subnet** --> <Subnet Name>).

The area shows the status of the port-subnet link and the speed of the connection. The **Link** field displays “Up” if the adjacent port is active, and “Down” if the adjacent port is inactive.

The area also shows the status of the port-WLAN associations. In this case, the adopted Access Ports for each of the associated WLANs are listed.

WAN Statistics

The WS 2000 Network Management System provides a set of screens that allow the administrator to view real-time statistics for monitoring the switch’s activity. One of those screens displays statistics for the Wide Area Network (WAN) port. Selecting **Status & Statistics** --> **WAN Stats** displays the following screen.



The **Information** portion of the WAN Stats screen displays general information about the WAN. Much of this information is generated from settings on the WAN screen in the Network Configuration area.

- The **Status** field displays "Enabled" if the WAN interface is currently enabled on the WAN screen (**Network Configuration** --> **WAN**). If the WAN interface is disabled on the WAN screen, the **WAN Stats** screen does not display connection information and statistics.
- The **HW address** is the Media Access Control (MAC) address of the switch's WAN port, which is set at the factory.
- The **Mask** field displays the subnet mask number for the switch's WAN connection. This number is set on the WAN screen.
- The **Link** field displays "Up" if the WAN connection is active, and "Down" if the WAN connection is interrupted or lost.
- The WAN connection speed is displayed in Megabits per second (Mbps), for example, 100 Mbps.
- The IP addresses displayed here for the WAN connection are set on the WAN screen (**Network Configuration** --> **WAN**).

The **Received** and **Transmitted** portions of the screen display statistics for the cumulative packets, bytes, and errors received and transmitted through the WAN interface, **since the WAN was last enabled or the switch was last rebooted**.

Received Field	Description
RX Packets	The total number of data packets received over the WAN connection
RX Bytes	The total number of bytes of information received over the WAN connection
RX Errors	The total number of errors including dropped data packets, buffer overruns, and frame errors on inbound traffic
RX Dropped	The number of data packets that failed to reach the WAN interface
RX Overruns	The total number of buffer overruns (when packets are received faster than the WAN interface can handle them)
RX Frame	The total number of TCP/IP data frame errors received

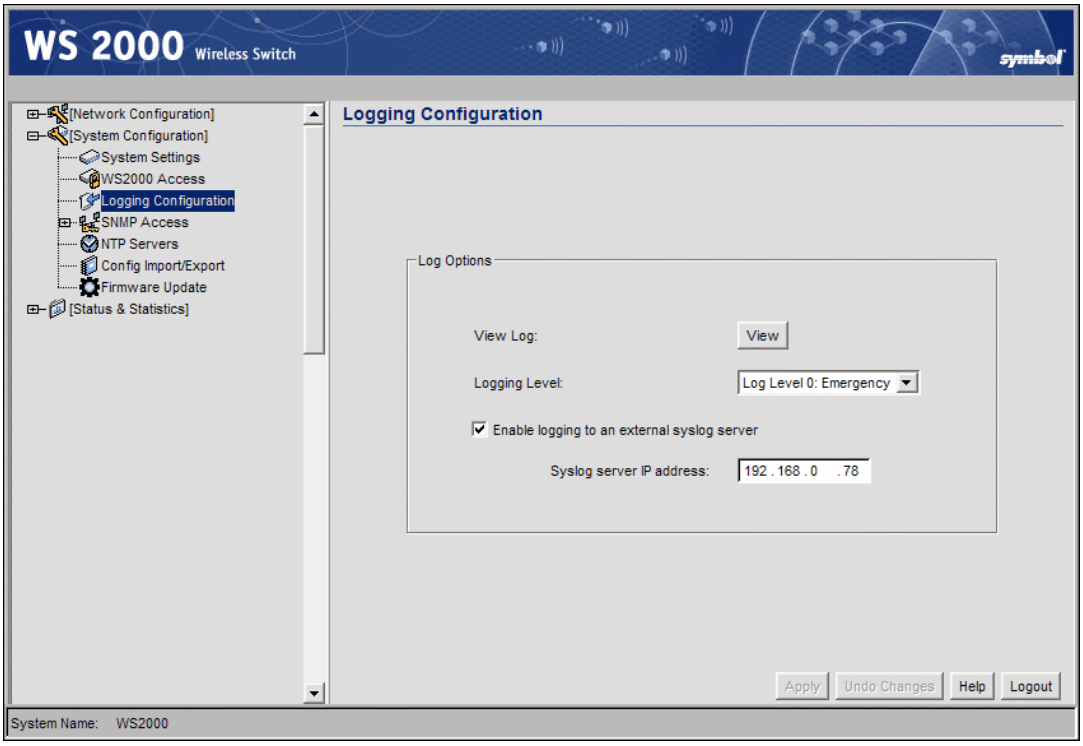
Transmitted Field	Description
TX Packets	The total number of data packets sent over the WAN connection
TX Bytes	The total number of bytes of information sent over the WAN connection
TX Errors	The total number of errors including dropped data packets, buffer overruns, and carrier errors that fail on outbound traffic
TX Dropped	The number of data packets that fail to get sent from the WAN interface

Transmitted Field	Description
TX Overruns	The total number of buffer overruns (when packets are sent faster than the WAN interface can handle them)
TX Carrier	The total number of TCP/IP data carrier errors received

Setting Up and Viewing the System Log

The WS 2000 Network Management System keeps a log of the events that happen on the switch. The switch has a modest of amount of memory to store events. If the administrator wishes to keep a more complete event history, the administrator needs to enable a log server.

To view the log or set up a log server, select **System Configuration** --> **Logs** from the left menu.



Viewing the Log on the Switch

To save a log of the most recent events that are retained on the switch, click the **View** button. The system will display a prompt asking for the administrator password. After the password has been entered, click the **Get File** button and a dialogue will be displayed with buttons to **Open** or **Save** the log.txt file. Click **Save** and specify a location to save the file.

To view the saved log.txt file on a Microsoft Windows based computer use the WordPad application. Viewing the log file with Notepad, the default text file view on most Windows based computers, will not properly display the formatting of the log file.

Setting Up a Log Server

To keep a complete history of the events that are logged by the switch, the administrator needs to set up an external system log on a server. The server listens for incoming switch-generated syslog messages on a UDP port (514 by default), and then decodes the messages into a log file appropriate for viewing and printing. Events are categorized into eight levels (0 through 7), with the lowest numbers representing the most critical issues.

1. Set the level of the errors to be logged from the Logging Level drop-down list. All events associated with the selected level and events with levels lower than the selection will be recorded.
2. Check the **Enable logging in to an external syslog server** checkbox to enable logging.
3. Specify the **Syslog server IP address** for the server that will store the log.
4. Select **Apply** to save the changes.
5. Select **Network Configuration** --> **Subnet Access**. Work through all the combinations of subnet-to-WAN accesses to ensure that DNS communications are allowed. (UDP must be enabled to save the log entries.)

Chapter 6. Retail Use Cases

Background

In the past, CCC clothing stores have used POS terminals with a 10BaseT Ethernet connection to an in-house server. Management has decided to install wireless networking in the stores. Wireless point of sale (POS) terminals and printers will allow them to be more flexible with store layout. Wireless handheld terminals for inventory and price lookup will make inventory faster and more accurate. In some stores, management is adding a cafe with free wireless Internet access. The hope is that customers will visit more often and stay longer if their partners can use the Internet while they shop.

The following links show the tasks that the system administrator will carry out to complete the wireless upgrade.

The Plan

Configuring the System Settings

Configuring the Subnets

- The IP Address Plan
- Configuring POS Subnet
- Configuring the Printer Subnet
- Configuring the Cafe Subnet

Configuring the WAN Interface

Configuring NAT

Inspecting the Firewall

Configuring the Access Ports

Configuring the WLANs

- Configuring the Cafe WLAN
- Configuring the Printer WLAN
- Configuring the POS WLAN

Setting Subnet Access

Configuring the Clients

Testing the Connections

The Plan

Clarisa is the employee assigned to implement the new network in San Jose. She needs three very different security policies. Wireless security policies are part of a WLAN configuration, so she will need three different WLANs.

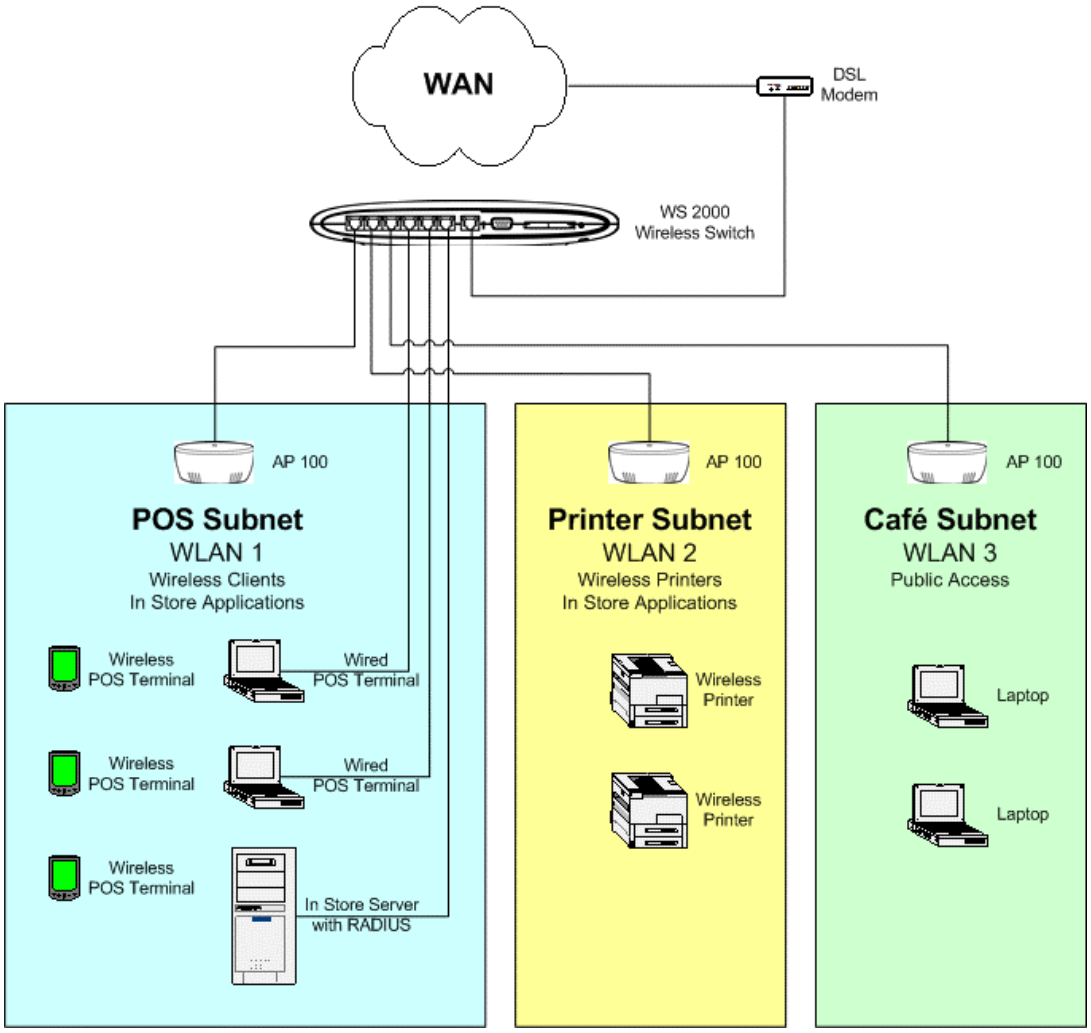
- WLAN #1: Confidential information, such as credit card numbers and customer purchases, will travel over the links to wireless POS terminals. For these, she wants the strongest security measures possible. The two components of a wireless security policy are user authentication and data encryption. The corporation has a RADIUS server for user authentication and it is a logical choice for this application. If the corporation did not have a RADIUS server, an alternative would have been to install Kerberos on the in-store server and use Kerberos user authentication. As for data encryption, WEP is not secure enough for this traffic. A survey of the wireless POS terminals reveals that they all support WPA-TKIP, so Clarisa will use WPA-TKIP for data encryption.
- WLAN #2: The wireless printers are difficult to misuse - no keyboards - and the data stream to them does not include any information that needs strong encryption. On this WLAN, Clarisa can limit user access by limiting connections to just those devices have their MAC addresses entered in the switch. The data will be WEP encrypted.
- WLAN #3: In the cafe, Clarisa wants an open network - no authentication or encryption. She believes that otherwise the support problems will be too difficult. But management wants to be absolutely certain that users of the cafe net cannot get access to the store computers or POS terminals. The WS 2000 allows the administrator to restrict access from one subnet to another, so Clarisa will create a subnet that is just for WLAN #3, and then restrict access from that subnet to the other subnets.

This plan covers all of the wireless devices — the POS terminals, the printers, and the customer laptops — except the wireless handheld terminals. Clarisa decides to put them on the WLAN with the POS terminals.

There are also some conventional, 100baseT wired devices to consider. There is the store server and two wired POS terminals. Clarisa will put all of these on the 100baseT ports on the WS 2000.

To keep things simple, Clarisa decides to define one subnet for each WLAN and assign one Access Port to each WLAN. The wired devices will be part of the POS subnet.

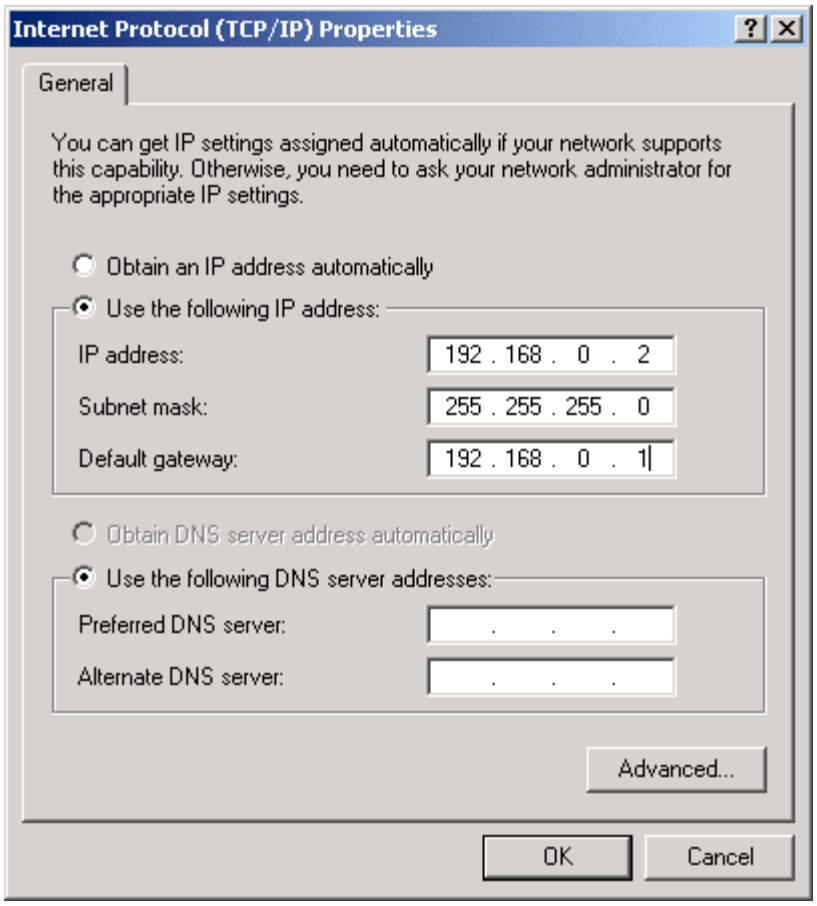
The WS 2000 will connect to the Internet through a DSL line.



Configuring the System Settings

Contacting the Wireless Switch

Clarisa sets up a direct network link between her laptop and the switch, plugging the cable into one of the local, non-WAN, ports. The switch defaults to having all the LAN ports on the first subnet and that subnet having an IP address of 192.168.0.1. So, as far as this connection is concerned, the switch comes up with an initial IP address of 192.168.0.1. She sets her laptop to have an IP address of 192.168.0.2 and a netmask of 255.255.255.0. She also sets the gateway IP address to be 192.168.0.1, the WS 2000's IP address.



Clarisa starts her web browser and enters “http://192.168.0.1/” as the URL. The WS 2000 sends a login page to her browser.

She logs in using “admin” for the username and “symbol” as the password.

Entering the Basic System Settings

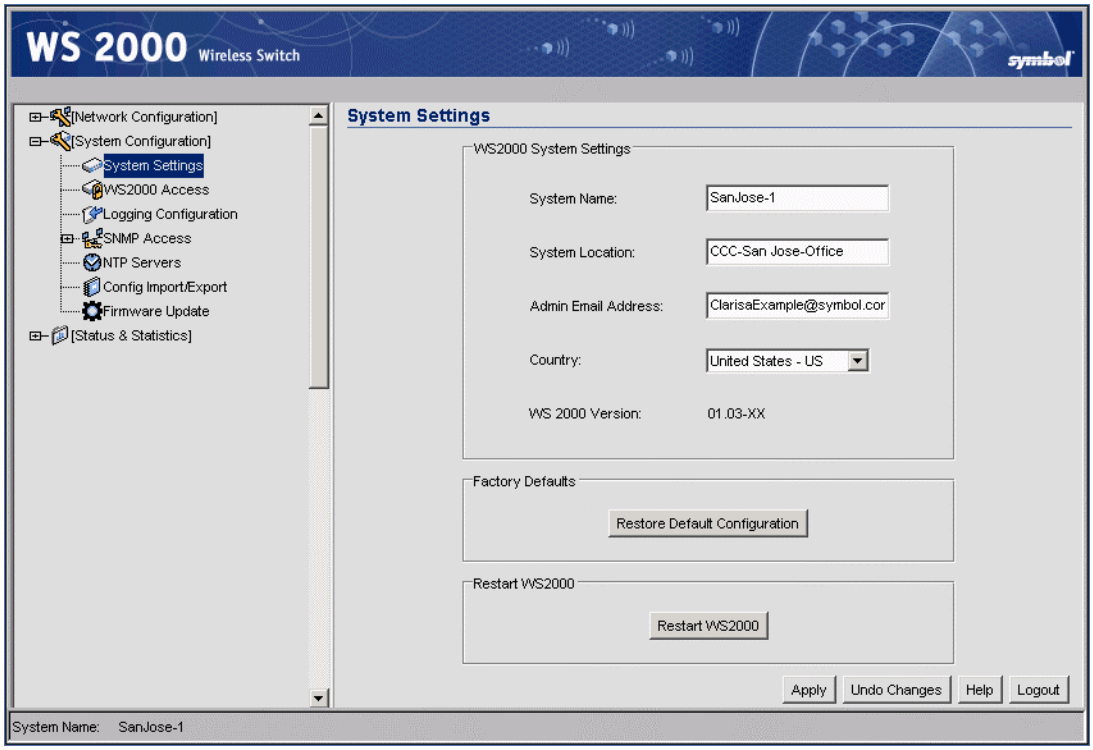
Clarisa selects **System Settings** in the left menu, located under the System Configuration heading.

The **System Name** is used to distinguish between WS 2000 switches for remote configuration. She gives the switch a descriptive name, “SanJose-1”. This name will appear in the footer for subsequent configuration windows for the switch. She does not need the name now, while she is in San Jose. But later, when she returns to corporate headquarters and wants to log into several switches remotely, it will help her to know which switch she is working on. She also enters a slightly longer description on the **System Location** field.

She enters her email address into the **Admin Email Address** box. CCC uses an SNMP manager that has the capability of monitoring network devices and sending email to the manager of a device that is in an unusual state. This is the email address that will be supplied to that SNMP manager for this switch.

She sets the **country** to “United States - US”. Different countries have different regulations for the use of these radio frequencies. Setting the location configures the switch to use only the channels, frequencies, and power levels that are legal for that country.

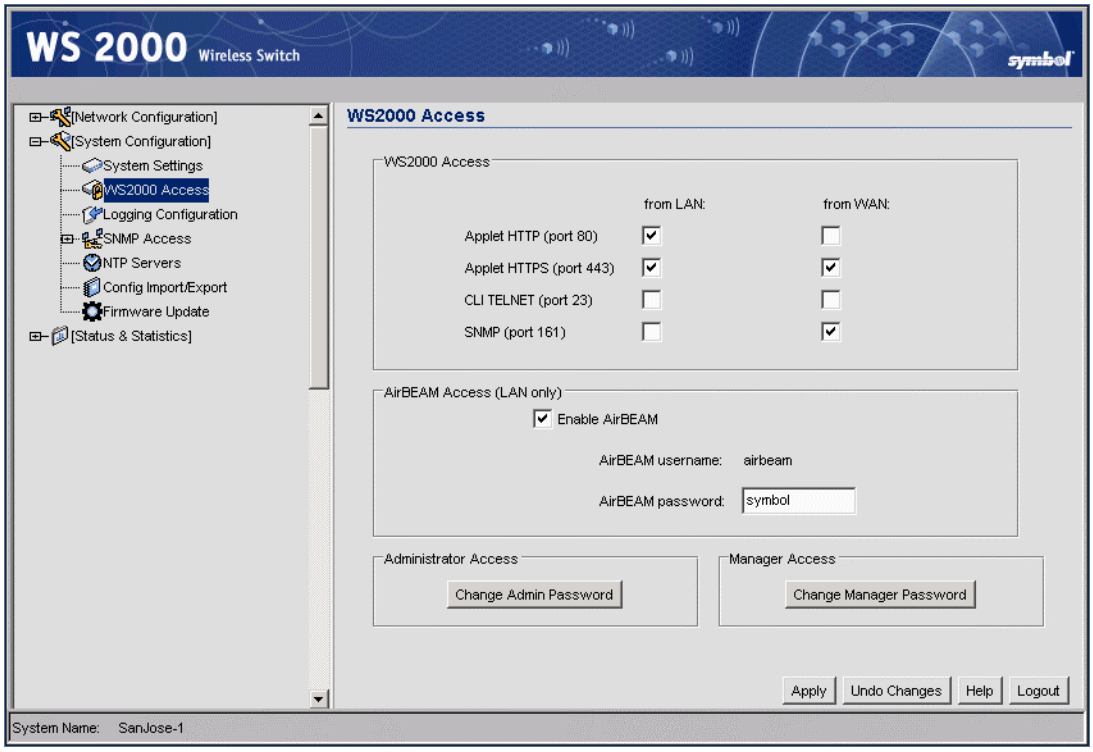
Clarisa clicks the **Apply** button to save her changes.



Setting Access Control

In the WS 2000 Access screen, Clarisa controls which network interfaces can be used to reconfigure the WS 2000 switch. She is currently using HTTP access on port 80 over the LAN, so she leaves that on. She wants to be able to manage the switch from corporate headquarters, but she does not want to leave the standard HTTP port, port 80, open over the WAN. She elects to leave port 443 open over the WAN instead. She knows she will want to monitor the switch from her SNMP system at corporate, so she leaves SNMP WAN access on.

AirBEAM is a Symbol Technology software system designed to simplify maintenance of wireless devices. CCC clothing recently purchased an AirBEAM license as part of a major commitment to Symbol Technology wireless bar code scanners for inventory. Clarisa would like to integrate the WS 2000 into the AirBEAM management system and she leaves AirBEAM access on. Clarissa changes the passwords for Administrator Access and for Manager Access to something relatively secure, something with letters, numbers, and punctuation marks in it.



Clarisa clicks the **Apply** button to save her changes.

Clarisa leaves the rest of the System Configuration screens for now, moves to the left menu, and clicks the "+" to the left of Network Configuration so that she can begin to define the subnets.

Configuring the Subnets

The IP Address Plan

Now Clarisa needs to name and define the subnets. The subnet menu items are under the LAN item in Network Configuration in the WS 2000 left menu. The subnets can be renamed, assigned an IP address, and have ports associated with them. Before she can do this, however, Clarisa needs to plan how she is going to assign IP addresses to the subnets and the devices on them.

Clarisa only has one IP address from corporate for this store. She will use network address translation (NAT) for all of the devices, making request from those devices look to the outside world as if they came from the single static IP address that she has. For the devices, she plans to use IP numbers from the range 192.168.*.*, because IP addresses in that range are designated for internal use only.

She will assign them as follows:

Subnet	IP Address Range
192.168.0.***	POS subnet
192.168.1.***	Printer subnet
192.168.2.***	Cafe Subnet

And for each subnet:

192.168.**.1	The subnet itself
192.168.**.2 to 192.168.**.10	Static IP addresses
192.168.**.11 to 192.168.**.254	DHCP-supplied IP addresses on the subnet

With this plan, she can begin to configure the individual subnets

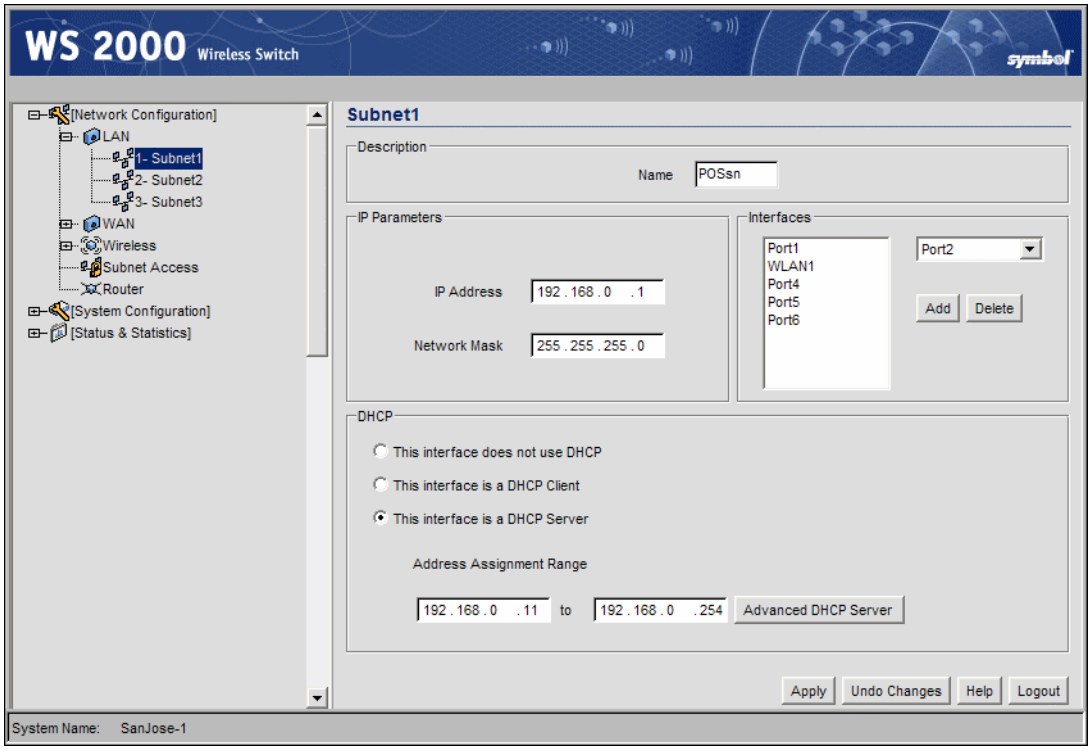
Configuring POS Subnet

Clarisa selects the first subnet from the LAN menu items in the left menu.

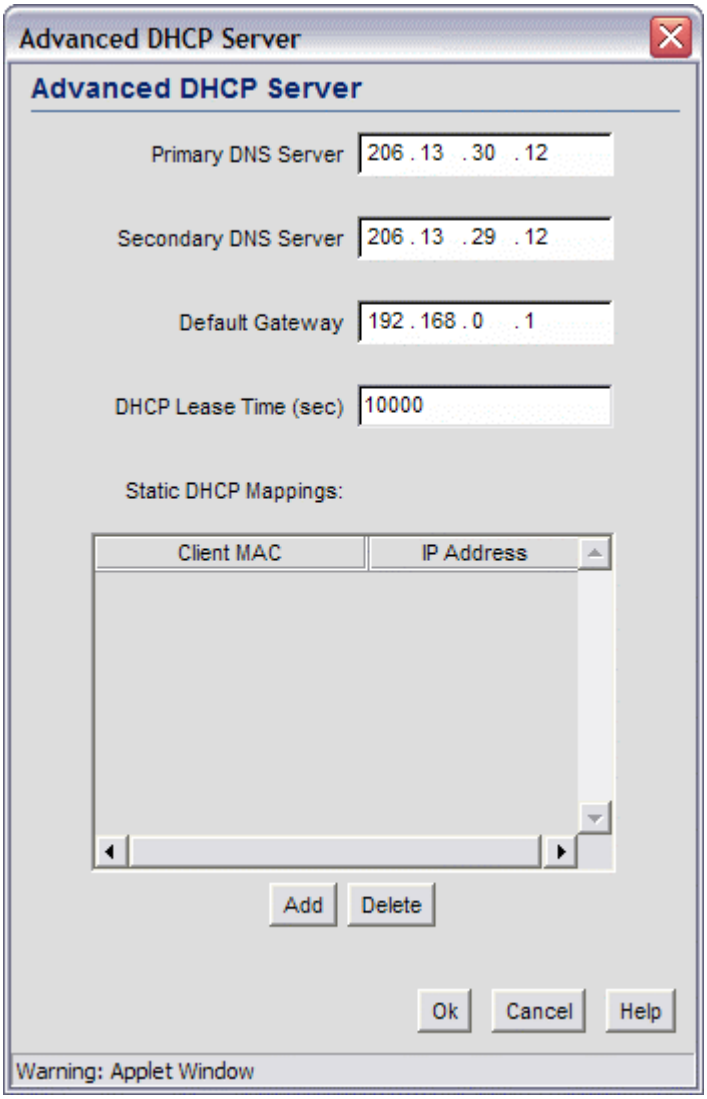
Clarisa renames this subnet “POSsn”, and then gives it an IP address of 192.168.0.1 and a subnet mask of 255.255.255.0. The devices on this subnet are:

- Everything on the POS WLAN: wireless POS terminals and wireless handheld terminals
- One wired POS terminal on port 4 and one on port 5
- One in-store server on port 6

Using the **Interfaces** section of the screen on the right, she associates the first WLAN with this subnet, as well as Ports 1 (the one the POS WLAN is plugged into), 4 and 5 (the wired POS terminals), and 6 (the server). She activates the DHCP server and gives it an IP address range of 192.168.0.11 to 192.168.0.254.



After she enters the **Address Assignment Range**, Clarisa clicks **Advanced DHCP Server**.



The **Default Gateway** is already set to the subnet address. This is the IP address to which the DHCP clients on this subnet will forward their outbound traffic. Clarisa fills in the **DNS Server** addresses that corporate has specified. This will also be supplied to the DHCP clients. The **DHCP Lease Time** is the time an IP address will remain assigned to a client after there is no more activity. She leave it at the default and clicks **Ok** to save her changes.

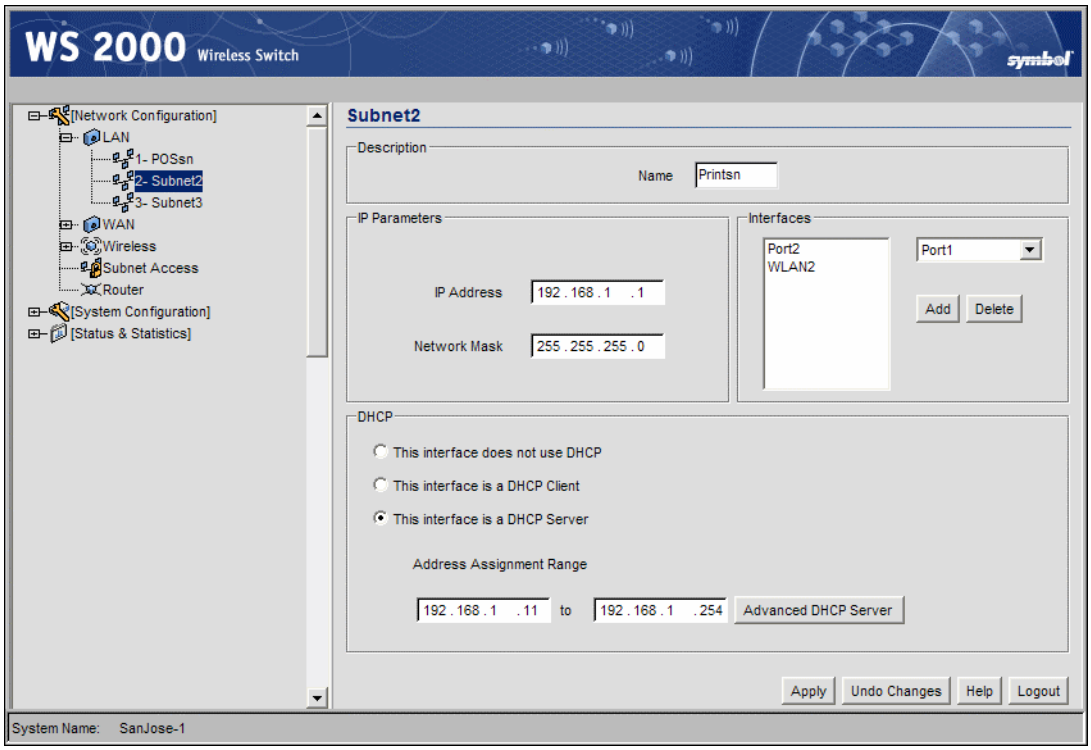
Then, in the subnet screen, she clicks **Apply** to save her overall changes.

Now she will configure the printer subnet.

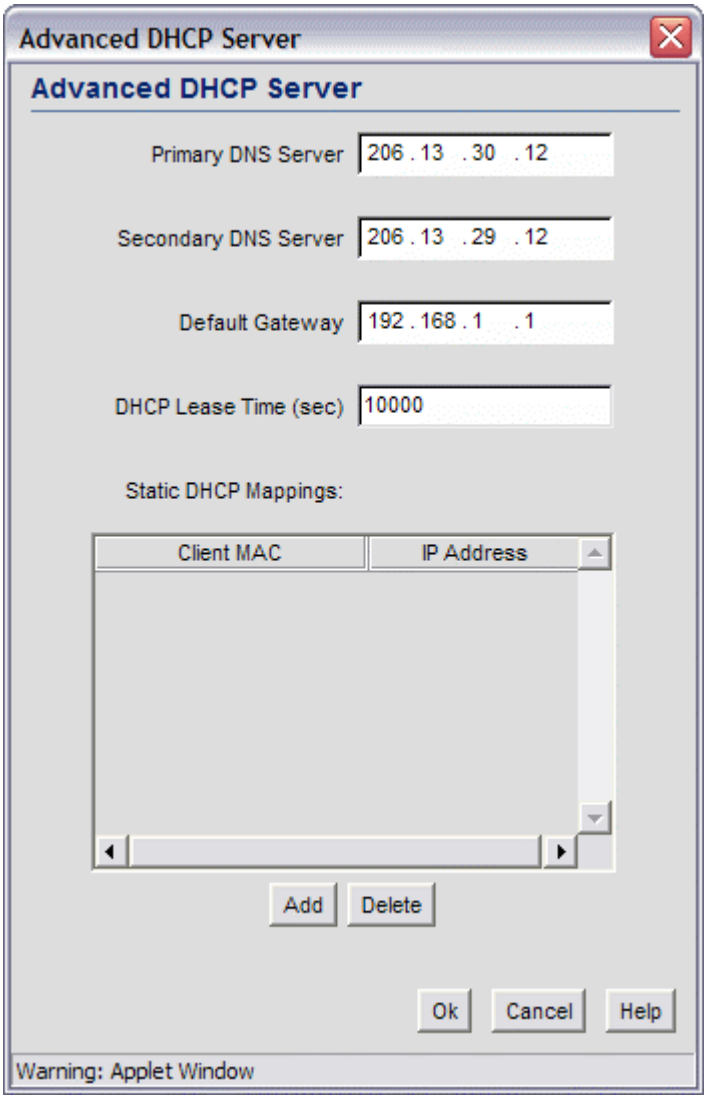
Configuring the Printer Subnet

Clarisa selects the second subnet from the list of LAN menu items in the left menu.

She renames this subnet “Printsn”, and then gives it an **IP address** of 192.168.1.1 and a subnet mask of 255.255.255.0. The only devices on this subnet are the wireless printers. Using the Interfaces section of the screen, she associates the second WLAN with this subnet. She activates the DHCP server with an IP address range of 192.168.1.11 to 192.168.1.254.



After entering the **Address Assignment Range**, Clarisa clicks **Advanced DHCP Server**.



Clarisa enters the DNS server IP addresses and leaves the **Default Gateway** and **DHCP Lease Time** at their defaults.

She clicks **Ok** in the **Advanced DHCP Server** window and then **Apply** in the Subnet window to save her changes.

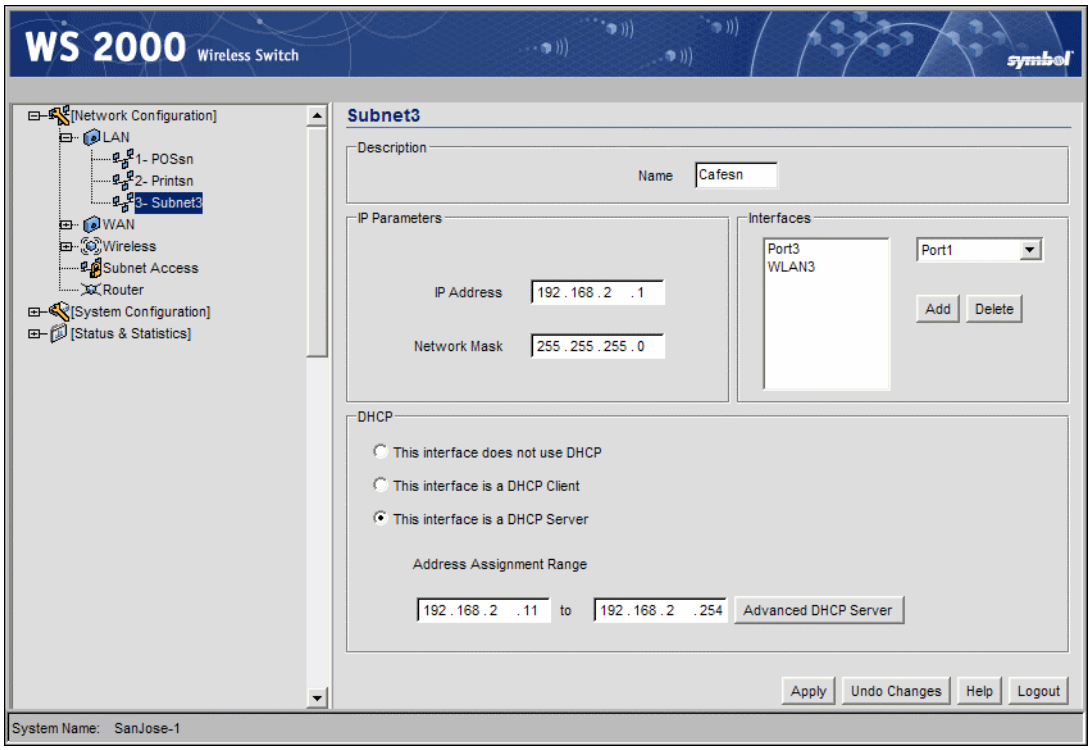
Now Clarisa will configure the Cafe subnet.

Configuring the Cafe Subnet

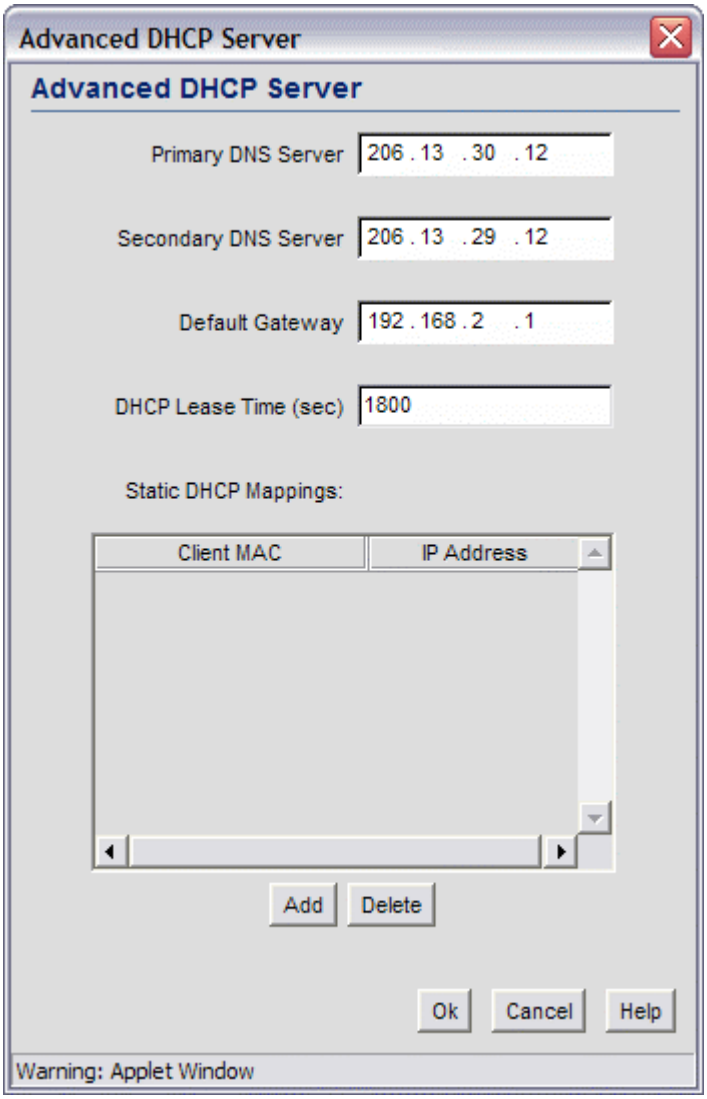
Clarisa selects the third subnet in the LAN menu list under **Network Configuration** in the left menu.

She then renames this subnet “Cafesn” and gives it the IP address 192.168.2.1 and a subnet mask of 255.255.255.0. The only devices on this subnet are the customer’s laptops in the cafe.

Using the Interfaces section of the screen, she associates the third WLAN with this subnet, and activates the DHCP server with an IP address range of 192.168.2.11 to 192.168.2.254.



Clarisa clicks **Advanced DHCP Server** and enters the DNS server IP addresses. The **Default Gateway** is fine. However, Clarisa expects the cafe patrons to come and go frequently, so she reduces the IP address lease time to 1800 seconds. This means that a DHCP client mobile unit will give up its IP address if it is inactive on the network for more than half an hour. This seems about right for the usage patterns that she expects for the cafe. If she gets complaints, she will bump it to an hour.

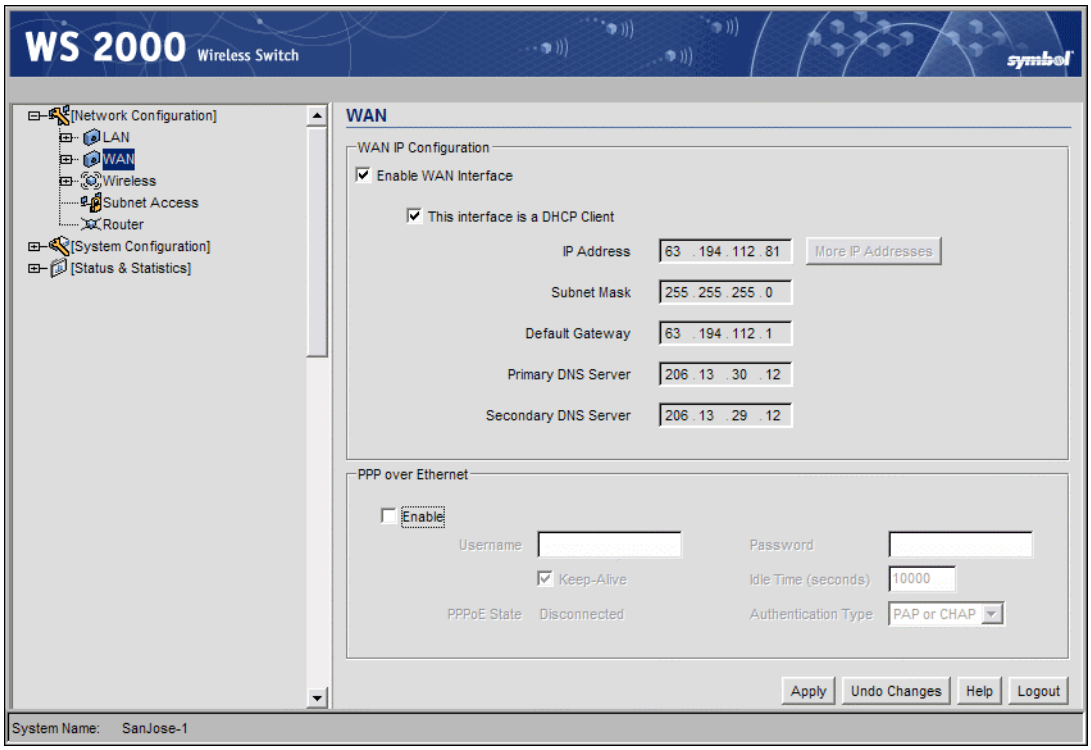


Clarisa clicks the **Ok** button in the **Advanced DHCP Server** window, then on the **Apply** button in the subnet screen to save her choices. The subnets are now configured.

Next Clarisa configures the WAN interface.

Configuring the WAN Interface

Now Clarisa selects the WAN node in the left menu. Here she enters the static IP address assigned to this store by CCC corporate. She also enters the other information supplied to her by corporate: the gateway IP address, the subnet mask, and the DNS server IP addresses. She is connecting by a DSL modem, but because she has a static IP address, her Internet service provider (ISP) does not require PPP-over-Ethernet connection information. If her ISP required PPPoE account information, she would have entered that information in the PPP-over-Ethernet section of the screen.



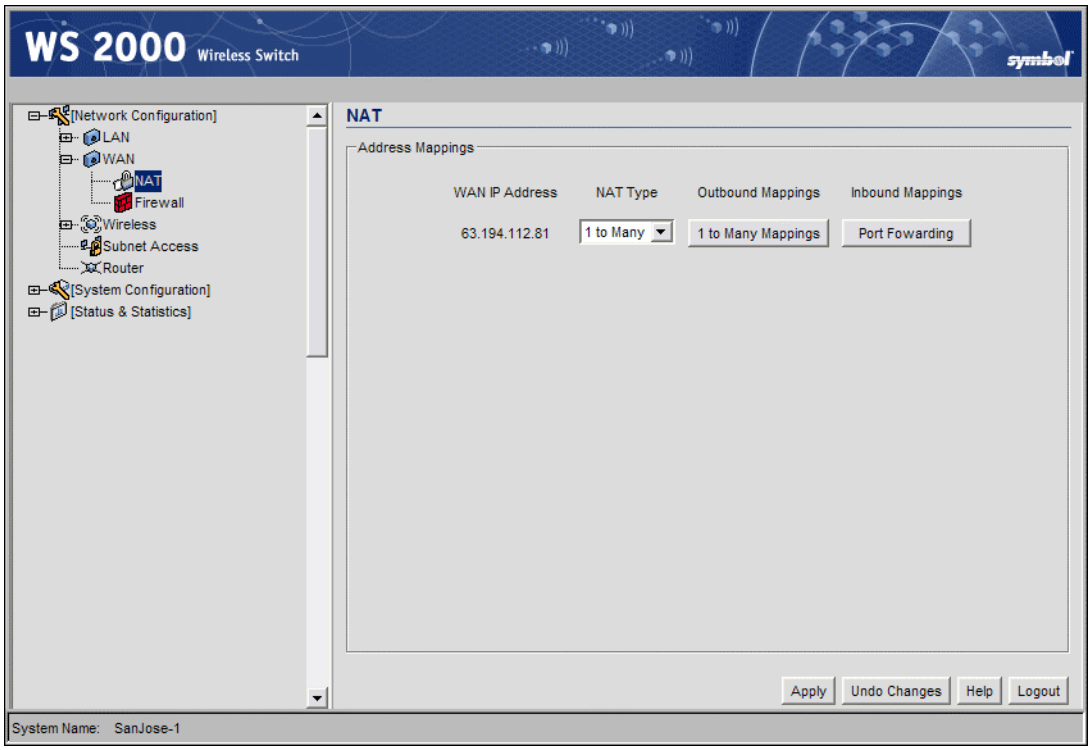
If corporate had not paid their ISP for a static IP address for each store, she would have selected the **This interface is a DHCP Client** option and the WAN configuration information would have been assigned by the ISP each time they connected to the Internet.

Clarisa clicks the **Apply** button to save her changes.

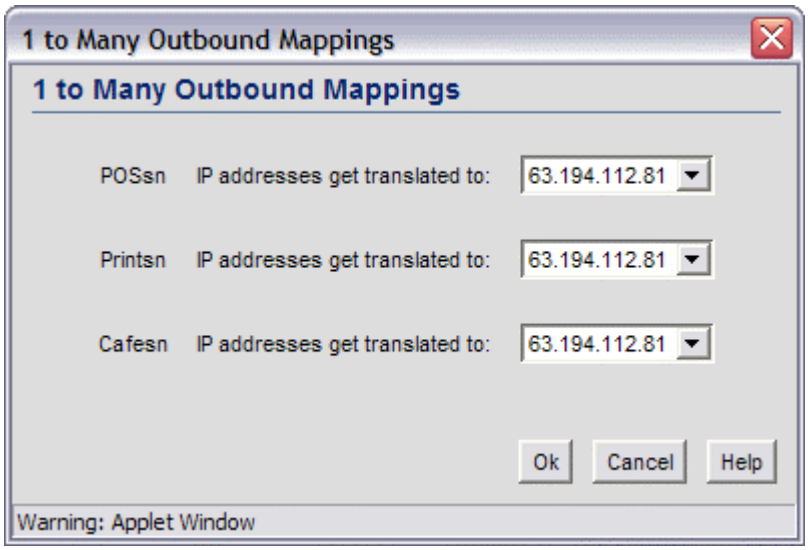
Configuring Network Address Translation (NAT)

Clarisa has only one public IP address for the whole store. She will use network address translation to make all request from the internal IP addresses to appear as if they came from the single public IP address.

She selects the **NAT** node under the **WAN** item in the left menu. The screen shows all IP addresses assigned to the switch in the WAN interface configuration step. In this case, there is one IP address shown. She selects **1 to Many** from the **NAT Type** menu to the right of the IP address.



After she makes this selection a new button appears, labeled **1 to Many Mappings**. She selects the **1 to Many Mappings** button:

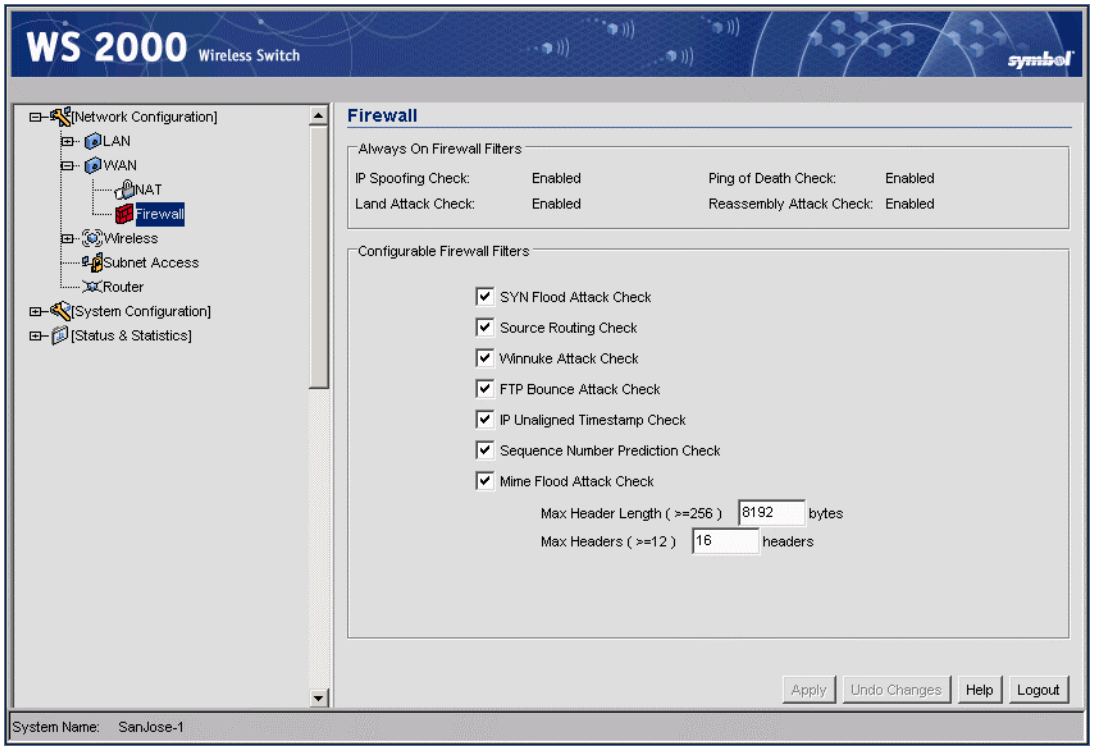


If Clarisa had more than one static IP address, she would have been able to assign several to the WAN interface. This screen is used to choose how the internal IP addresses on each subnet translated into the selection of external IP addresses. However, she has only one external IP address. All requests from any IP address on the store network are translated into a request using the single public IP address for the store.

Clarisa clicks the **Ok** button to confirm the Outbound Mappings and then clicks the **Apply** button in the main screen to confirm the NAT choices and save her choices on the switch.

Inspecting the Firewall

Clarisa selects the Firewall item in the left menu. Each of the checkbox items represents a type of attack the WS 2000 can filter out. She checks to see that all of the options are enabled.



Clarisa clicks the **Apply** button to confirm that all attacks listed will be filtered.

Configuring the Access Ports

So far, Clarisa has been operating with the WS 2000 connected only to her laptop. To configure the Access Ports, she will need to connect them to the switch. She plans to use switch ports as follows:

Switch Port	Connected to
Port 1	Access port for the POS WLAN
Port 2	Access port for the Printer WLAN
Port 3	Access port for the Cafe WLAN
Port 4	Wired POS terminal #1
Port 5	Wired POS terminal #1
Port 6	In-store server

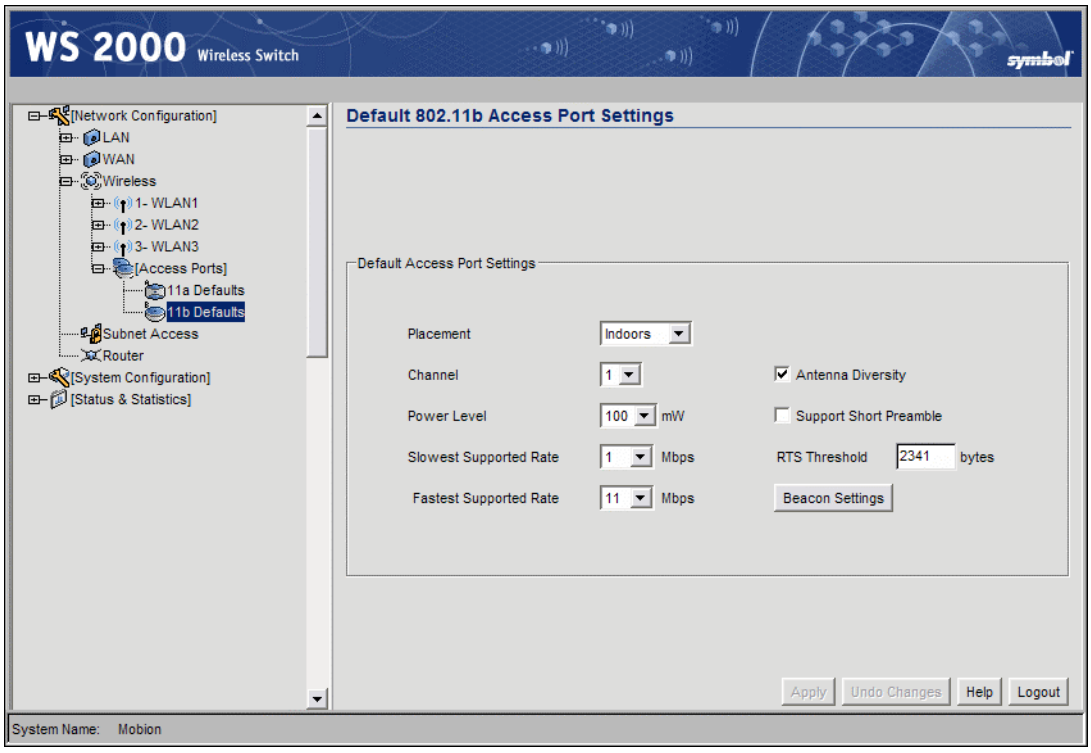
Setting Access Port Defaults

The WS 2000 allows the user to specify the default settings for Access Ports. Clarisa expands the Access Ports node in the left menu and selects the **11b Defaults** node. Clarisa has only 802.11b Access Ports.

All of the Access Ports will be indoors, so she specifies **Placement** as Indoors. She leaves **Channel** set to one and will reset each Access Port to a different 802.11b channel later. She sets the **power level** to 100mW, the maximum level allowed in the US.

She leaves the **Slowest Supported Rate** and the **Fastest Supported Rate** as they are. The switch will operate at the maximum rate allowed by radio conditions, scaling back as needed. She sees no reason to change those parameters.

She does not change the **Antenna Diversity** setting, **Short Preamble** setting, **RTS Threshold**, or the **Beacon Settings**. These parameters control some of the broadcast mechanics of an 802.11 conversation between mobile units and Access Ports. In most cases, there is no reason to change them.

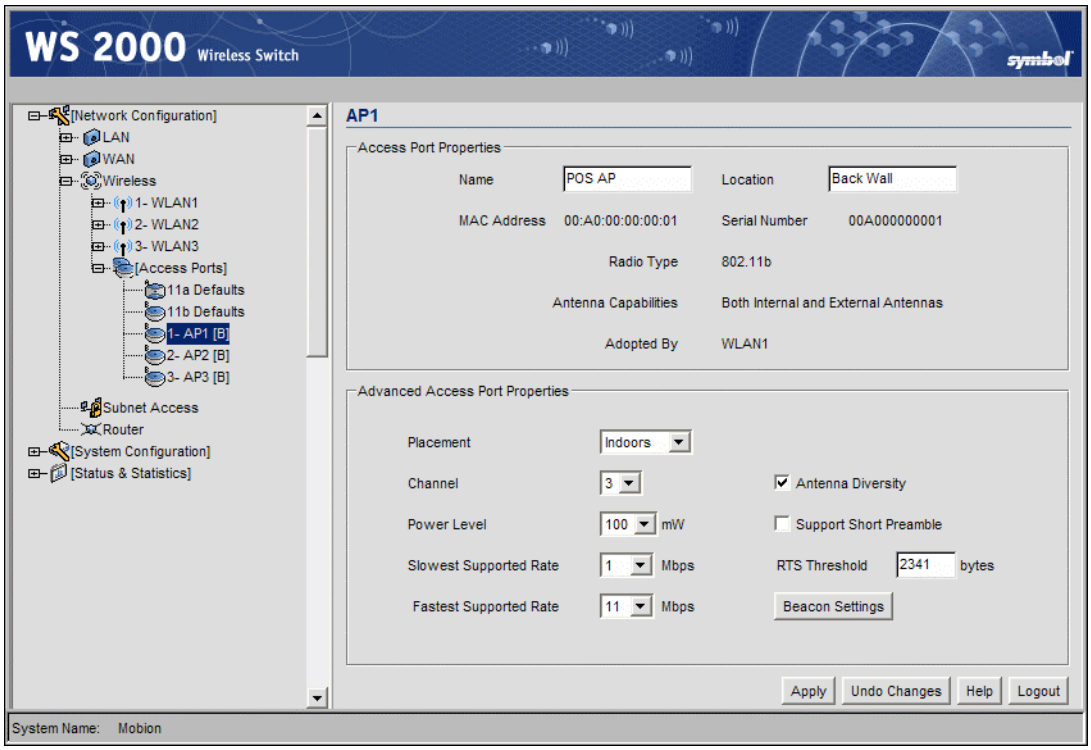


Clarisa clicks **Apply** to save her changes.

After setting the default settings for 802.11a and 802.11b access ports, Clarisa removes the Access Ports from their packaging and labels the each with the name of the WLAN that it will support. She connects the Access Ports to the switch, using the ports selected in her plan.

Naming the POS Access Port

Having specified the general Access Port default values, Clarisa goes on to name and configure the Access Port for the POS WLAN. She selects the first Access Port in the left menu.



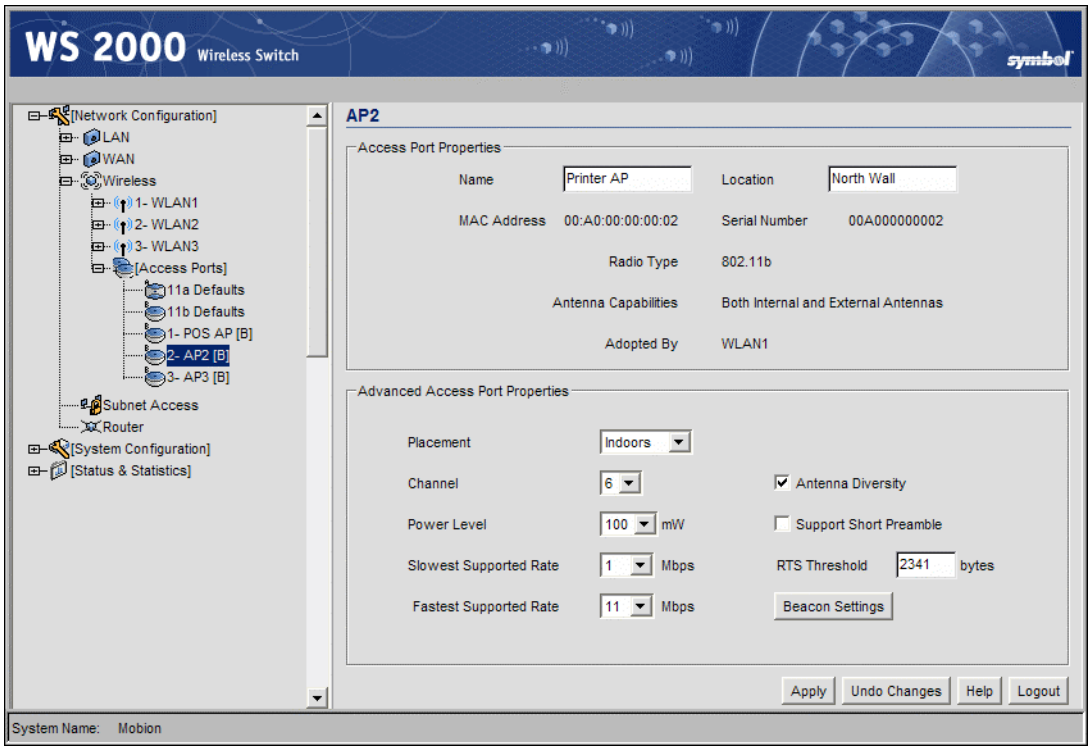
In the Access Port Properties section, Clarisa enters a new name for the Access Port and a brief description of its permanent location.

In the **Advanced Access Port Properties** section, Clarisa sets the **Channel** to 3. She knows that the store uses cordless phones that transmit on channel 1. She also wants to maintain some separation between the channel used by this Access Port and the other Access Ports at this location.

She does not change any of the other settings. She clicks the **Apply** button to save her changes.

Configuring the Printer Access Port

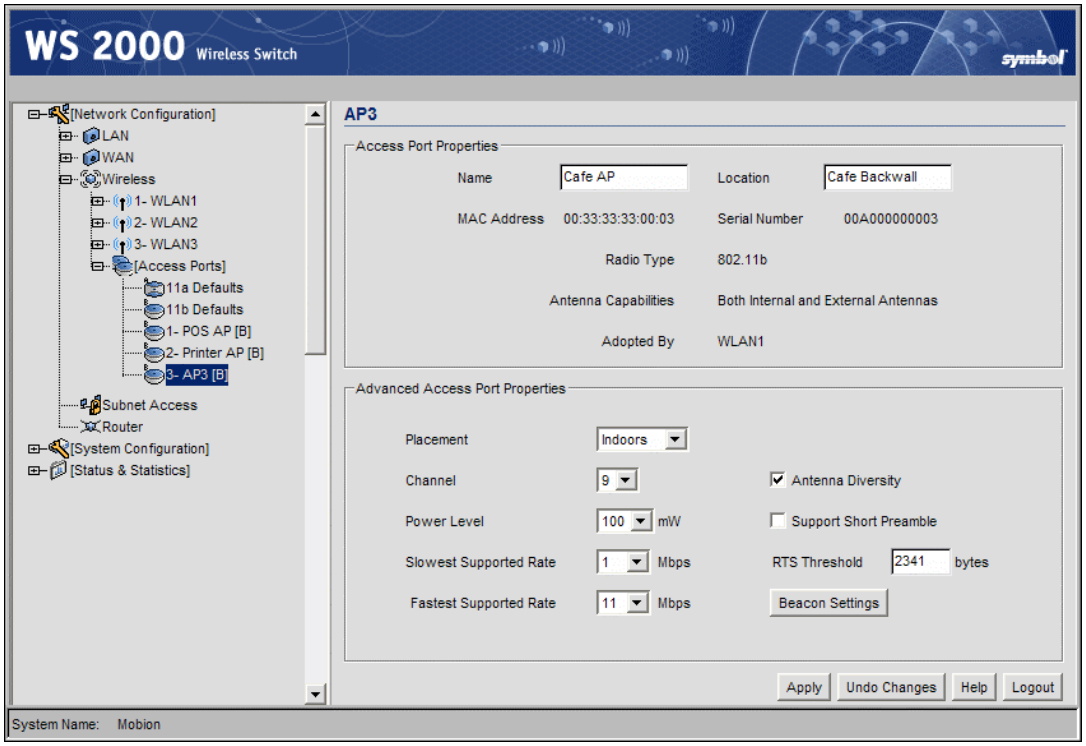
Clarisa configures the Printer Access Port in a similar way. She gives it the name “Printer AP” and a location description. She assigns channel 6 to this Access Port, avoiding contention with the POS AP and the Cafe AP.



She clicks the **Apply** button to save her changes.

Configuring the Cafe Access Port

Finally, she names the third Access Port “Cafe AP” and sets **Channel** to 9. In this case she makes sure **Support Short Preamble** is not selected. There are two preambles in use in the wireless world, an older, longer one and a newer, shorter one. Most wireless devices support both and use the shorter one by default. However, in the cafe, there will be older wireless devices coming in and rather than confuse them, she will stick with the longer preamble on this WLAN.



Again, she clicks the **Apply** button to save her changes.

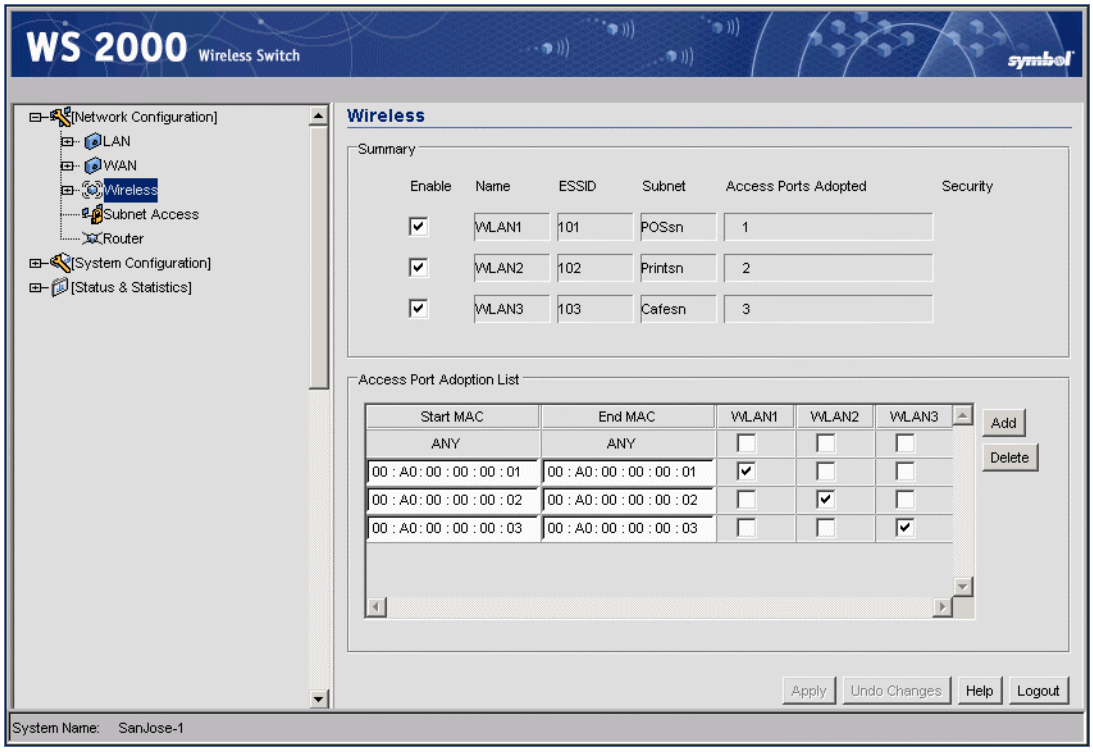
Associating the Access Ports to the WLANs

Now Clarisa selects the **Wireless** item in the left menu. This screen indicates which Access Ports are associated with which WLANs.

First Clarisa looks in the **Summary** section of the screen to determine that all three WLANs are enabled.

In the **Access Port Adoption List** section, the screen begins with a single line with "ANY" as the **Start MAC address**, "ANY" as the **End MAC address**, and checks under all three of the WLANs. Clarisa removes the checks from the WLAN checkboxes.

Clarisa clicks the **Add** button and then enters the MAC address for the POS Access Port as the **Start MAC** address. She then selects the checkbox for WLAN1, the WLAN that supports the POS terminals. Similarly, Clarisa clicks the **Add** button, enters the MAC address for the Printer WLAN and puts it on WLAN2. Finally, she clicks the **Add** button a third time, enters the **Start MAC** address for the Access Port for the Cafe WLAN and selects the checkbox for the Cafe WLAN.



Clarisa clicks the **Apply** button to save her choices.

Configuring the WLANs

Configuring the Cafe WLAN

Clarisa clicks the "+" to the left of the Wireless menu item in the left menu. She selects the third WLAN. This is the WLAN that she plans to use for the cafe WLAN.

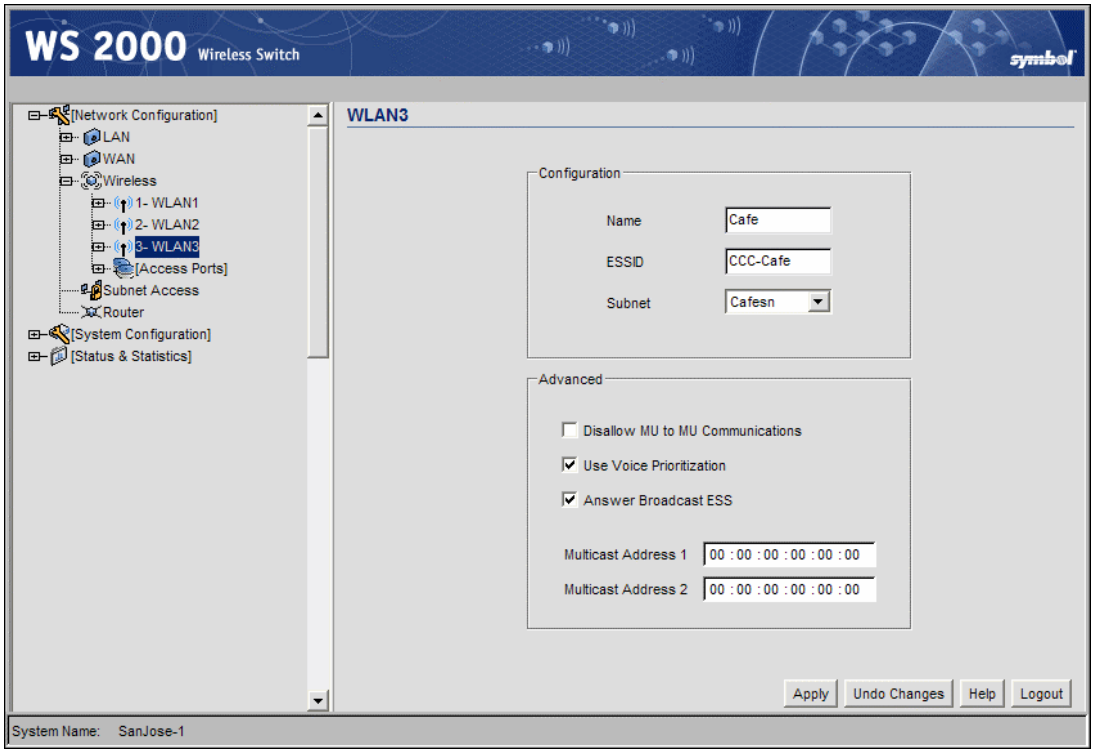
The WLAN name is used with in the WS 2000 configuration screens to make the interface easier to navigate. She names this WLAN from "WLAN3" to "Cafe". She also gives it an **ESSID** of "CCC-Cafe". The ESSID is broadcast to the users and will be what the cafe users see when they select a wireless network on their laptops. Finally, she uses the Subnet pull-down menu to make this WLAN part of the third subnet, the "Cafesn" subnet.

For **Disallow MU to MU communications**, she leaves the option unchecked. She is certain that some cafe users will want to communicate between themselves, so she does not choose the **Disallow**.

She leaves the **Voice Prioritization** option checked. It is unlikely that many customers will want to use Voice over IP products in the near future, but there seems to be no reason for her to disallow such use.

She also leaves on **Answer Broadcast ESS** for this WLAN. Some mobile units come with a default ESSID of "101". This option allows the WLAN to respond to these mobile units even if the WLAN is set up with a different ESSID. Since the cafe is a public access WLAN, leaving this option on will make it easier for the cafe customer to associate with the WLAN. For the private WLANs on this switch, she will turn this option off.

The options for **Multicast Addresses** are designed for compatibility with some VoIP phones. Clarisa thinks it unlikely that any will show up in the cafe so she leaves these blank.



She clicks the **Apply** button to save her choices.

Clarisa goes to the left menu and clicks the "+" to the left of the Cafe WLAN node. A menu item labeled **Cafe Security** appears and Clarisa selects it.

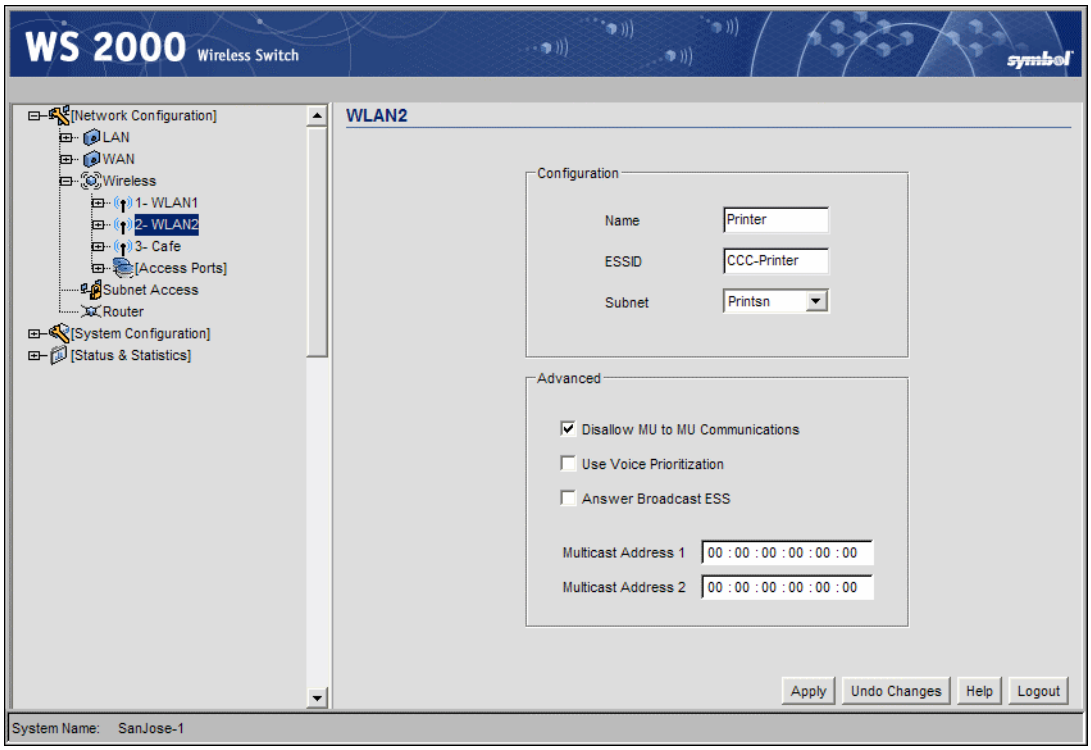
She confirms that the Cafe Security screen shows that no authentication and no encryption methods.

Configuring the Printer WLAN

For the printer WLAN, Clarisa makes the following selections:

Name	**Printer**
ESSID	CCC-Printer
Subnet	Printsn
Disallow MU to MU Communication	Yes
Use Voice Prioritization	No
Answer Broadcast ESS	No

There will not be any VoIP devices in the store, therefore voice prioritization will not be useful. The wireless printers will never need to communicate with each other directly. MU to MU communications can be safely disallowed. Allowing **Answer Broadcast ESS** is a way to allow mobile units that are not configured with the network ESSID to associate with the WLAN. She knows that she will configure all of the mobile units on this WLAN with the correct ESSID, so she disallows this option, potentially keeping a cafe customer out of the printer WLAN.



Clarisa clicks the **Apply** button to confirm her choices.

Clarisa clicks the "+" to the left of the Printer WLAN menu item and selects the **Printer Security** item. In the screen that displays, Clarisa selects no authentication. She enters the MAC numbers of the wireless printers in the Mobile Access Control section. The MAC numbers are unique numbers assigned to every network-cable hardware device and are usually listed on the same label that shows the device's model number and serial number. She enters each by clicking on the **Add** button and entering the MAC address in the **Start MAC** column of the new row.

Configuring the POS WLAN

For the POS WLAN, she makes the following choices:

Name	**POS**
ESSID	CCC-POS
Subnet	POSsn
Disallow MU to MU Communication	No
Use Voice Prioritization	Yes
Answer Broadcast ESS	No

None of the current handheld terminals have voice capability, but the handhelds come in a model that has a walkie-talkie voice functionality. Clarisa believes that management might want to try those models soon. She elects to allow voice calls to get priority and, because the handhelds would be calling each other, she allows mobile unit (MU) to mobile unit communications. Allowing **Answer Broadcast ESS** is a way to allow mobile units that are not configured with the network ESSID to associate with the WLAN. She knows that

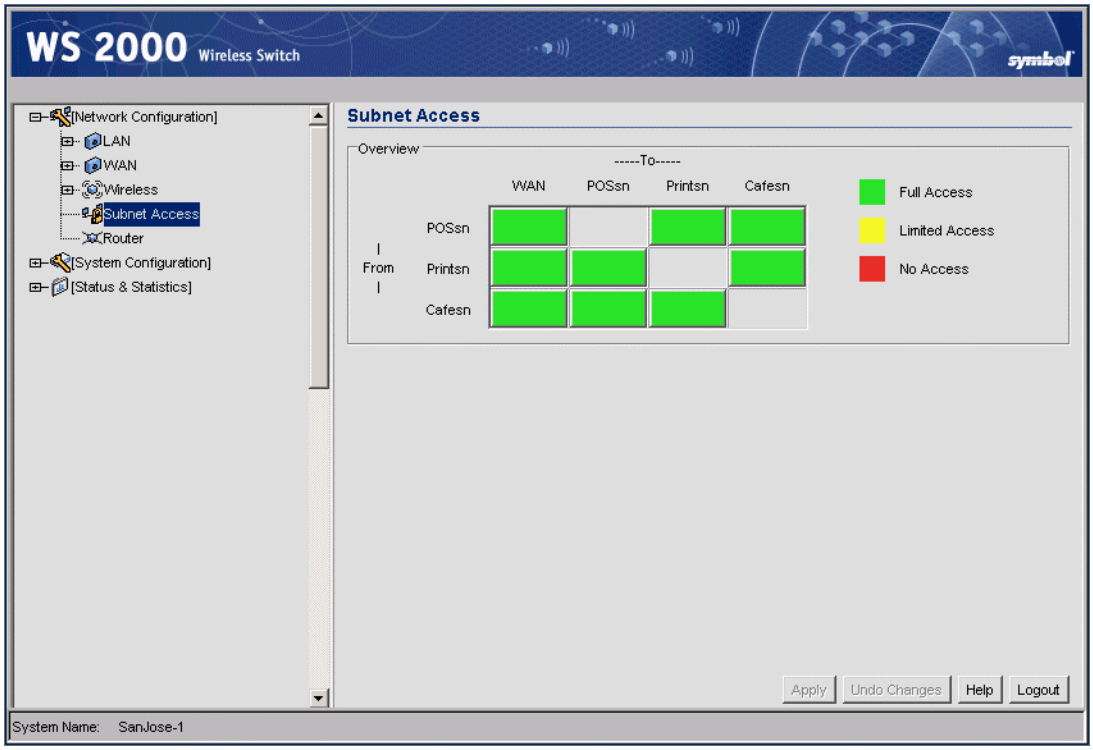
she will configure all of the mobile units on this WLAN with the correct ESSID, so she disallows this option, potentially keeping a cafe customer out of the POS WLAN.

The options for Multicast Addresses are designed for compatibility with some VoIP phones. Clarisa does not know if the voice handhelds will require it but, even if they do, she will not know the required multicast addresses until they are purchased and arrive. She leaves the Multicast Addresses blank.

Setting Subnet Access

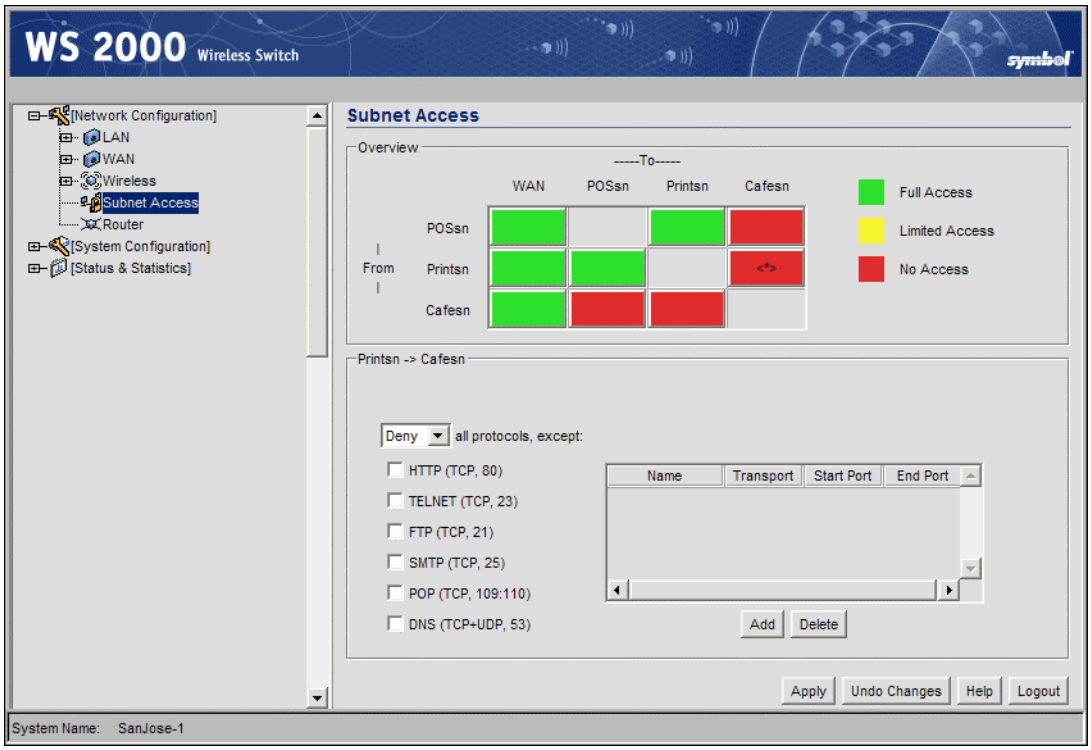
Clarisa wants the two internal subnets to have complete access to one another, but she wants the Cafe subnet to have access only to the WAN.

She selects the **Subnet Access** node in the left menu.

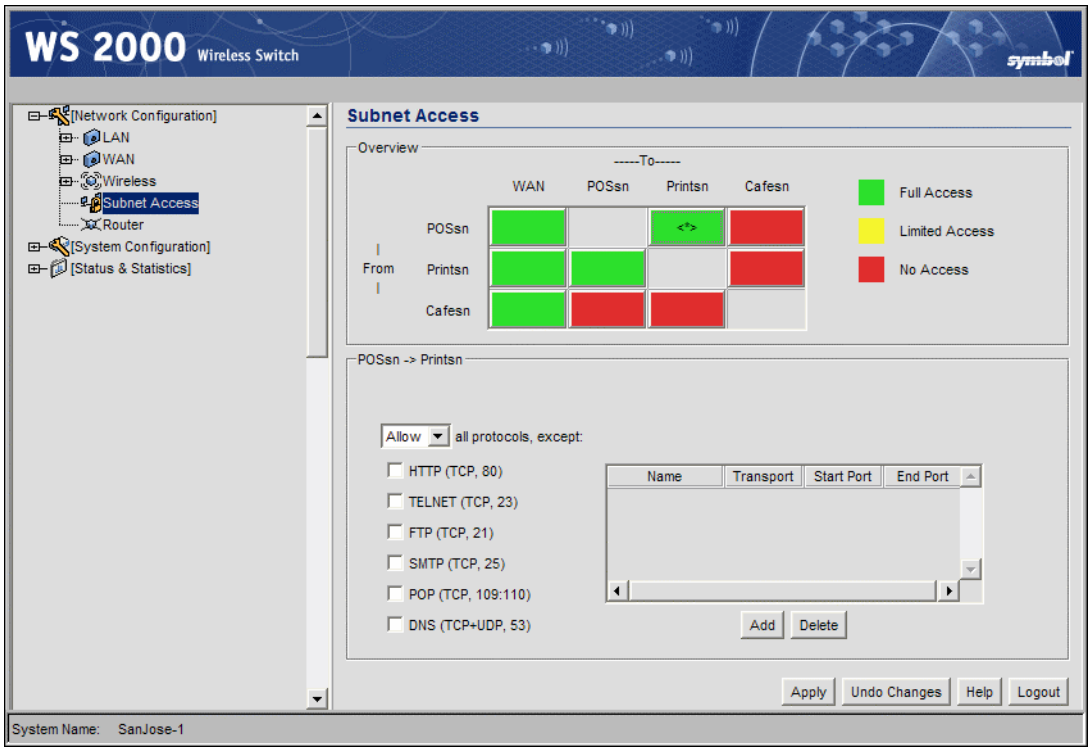


To set the subnet access for a pair of subnets, she clicks the square for traffic from one subnet to another and then uses the detail section, which appears below, to determine the rules for traffic between those two subnets.

She allows the Cafe subnet to have full access to the WAN. For the Cafe subnet to of from any other internal subnet, she selects the appropriate square, then uses to the detail box below to **Deny** all protocols.



For the POS subnet and the Printer subnet, she selects **Allow** all protocols when going to the WAN, the POS subnet, and the Printer subnet.



After specifying all of the subnet access rules, she clicks the **Apply** button to save her changes.

Configuring the Clients

Clarisa has now finished configuring the switch. Next, she configures the wired clients.

Going to each device, she gives it the IP address and other networking information that it will need to communicate with the switch:

Client	IP Address	Subnet Mask	Gateway	WS 2000 Port
Wired POS terminal #1	192.168.0.4	255.255.255.0	192.168.0.1	4
Wired POS terminal #2	192.168.0.5	255.255.255.0	192.168.0.1	5
Server	192.168.0.6	255.255.255.0	192.168.0.1	6

Then she does the same thing with the wireless clients:

Client type	WLAN ESSID	Wireless channel	Authentication	Encryption
Wireless POS terminals	CCC-POS	3	802.1x EAP	WPA-TKIP
Handheld terminals	CCC-POS	3	802.1x EAP	WPA-TKIP
Wireless printers	CCC-Printers	7	None	WEP

The remaining tasks are to test the network and to put the Access Ports in their permanent locations.

Testing Connections

Clarisa powers up several sample devices and tests them, to be sure that they work as configured. She tests whether the devices can connect to the wireless switch and whether they can connect to devices on other subnets.

After she is confident that everything is working, she moves the Access Ports to their permanent locations. She connects the WS 2000 to the DSL modem. Finally, she tests the connection from each subnet to the WAN.

The store network is now complete!

Chapter 7. A Field Office Example

Background

Leo is the network administrator, system administrator, and IT professional for a field office with 60 employees. The users include sales people, sales engineers, office administration and customer support people. All of the sales personnel have laptops and many of them have personal digital assistants (PDAs).

The office is connected to the Internet and to Corporate through a frame relay link. Between the office network and the frame relay, there is a router and a virtual private network (VPN) appliance. The VPN appliance encrypts all traffic to Corporate. Traffic to other addresses passes straight through.

Leo installed a wireless access point about six months ago and quickly found that many employees preferred to use it. However, the throughput of the lone unit was not enough to service 40 or so users and coverage was weak in many areas of the building. In addition, Leo was doing user authentication by maintaining a list of permissible user MAC addresses on the access point. This required modifications to the list once or twice a week. Recently, when a laptop was stolen, Leo could not determine which MAC address to remove from the list for several hours. He concluded that he needed to use a better method of user authentication. Also, the data encryption on the old access point was WEP and WEP encryption can be broken with several hours of data encrypted with the same key. Leo changes the key every week, but some users complain when last week's key does not work anymore.

Leo has decided to upgrade to a WS 2000 wireless switch. He will have four Access Ports, one in the administration office area, one in the sales office area, one in the sales engineering area, and one in the engineers' demonstration room. Throughput and coverage will increase significantly. Leo will convert to 802.1x/EAP-TTLS user authentication through the corporate RADIUS server and convert to WPA encryption, improving security considerably and reducing maintenance significantly.

The following links show the tasks that Leo will carry out to complete the wireless upgrade.

- The Plan
- Configuring the System Settings
- Configuring the LAN
- Configuring the WAN
- Setting up NAT
- Confirming the Firewall
- Adopting the Access Ports
- Configuring the WLANs
- Configuring the Access Ports
- Specify Subnet Access
- Install Access Ports and Test

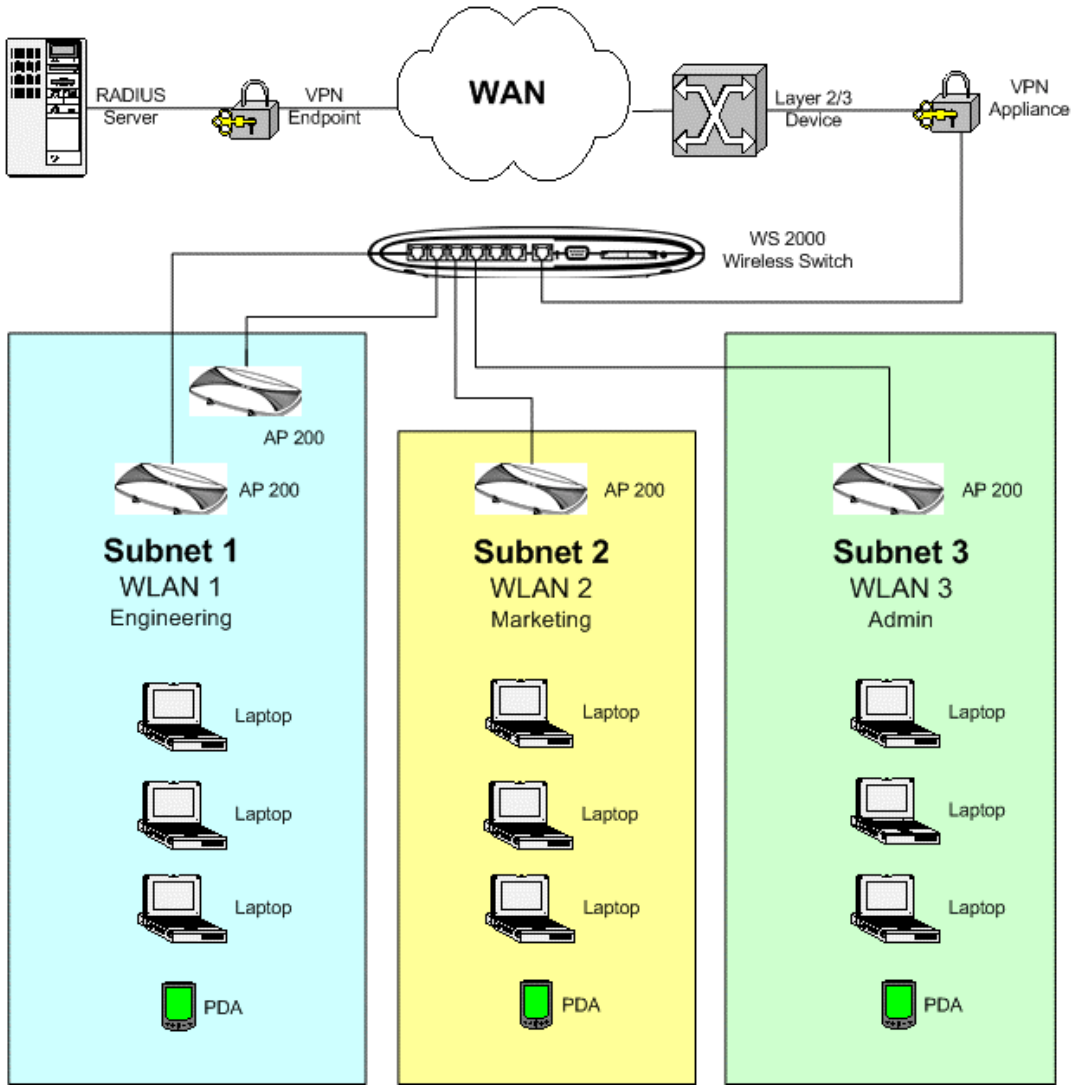
The Plan

Each WS 2000 WLAN has exactly one security policy, where a security policy is defined as a user authentication method and a data encryption method. Because each WLAN can have one and only one security policy, WLAN configuration is usually defined by the security needs of the installation. If two groups of users require different security policies, then they must associate to the WS 2000 through different WLANs. See the Retail Use Case for an example of an installation where different security needs drive the need for separate WLANs.

In this situation, all of Leo's users will use the same security system: 802.1x/EAP-TTLS user authentication and WPA data encryption. Leo can set up the WLANs in any way that is convenient.

Corporate has given Leo three static IP addresses for the wireless network. He will configure the WS 2000 as a DHCP server giving out internal-use-only IP addresses and use network address translation (NAT) in the switch to convert the outward-bound traffic to one of the static IP addresses.

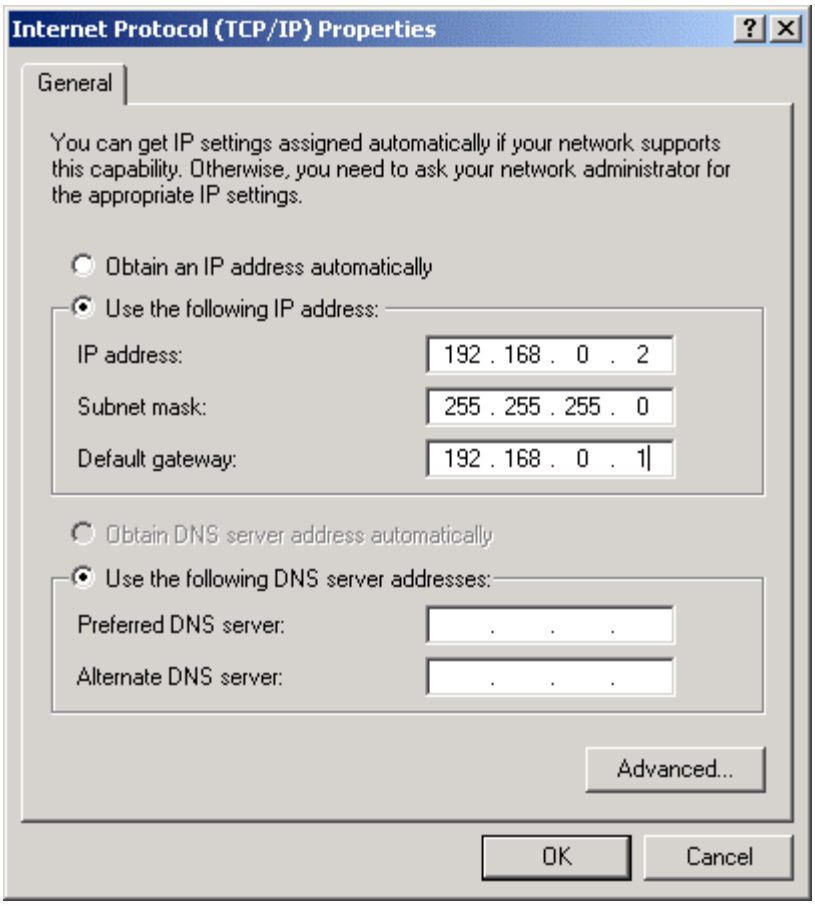
To keep things simple, he will define one subnet for the administration users, one subnet for the sales and marketing users, and one subnet for the engineers. Each subnet will have one WLAN associated with it and one Access Port. The only exception is the engineering subnet, which will have one WLAN and two Access Ports. All of the subnets will have access to all of the other subnets and to the WAN.



Configuring the System Settings

Contacting the Wireless Switch

To begin configuration of the switch, Leo sets up a communication link to the switch. Leo starts with a direct network link between his laptop and the switch, plugging the cable into one of the local, non-WAN, ports. The switch defaults to having all the LAN ports on the first subnet and that subnet having an IP address of 192.168.0.1. So, as far as this connection is concerned, the switch comes up with an initial IP address of 192.168.0.1. He sets his laptop to have an IP address of 192.168.0.2 and a netmask of 255.255.255.0. He also sets the gateway IP address to be 192.168.0.1, the WS 2000's IP address.



Leo launches his web browser and enters “http://192.168.0.1/” as the URL. He logs in using “admin” for the username and “symbol” as the password.

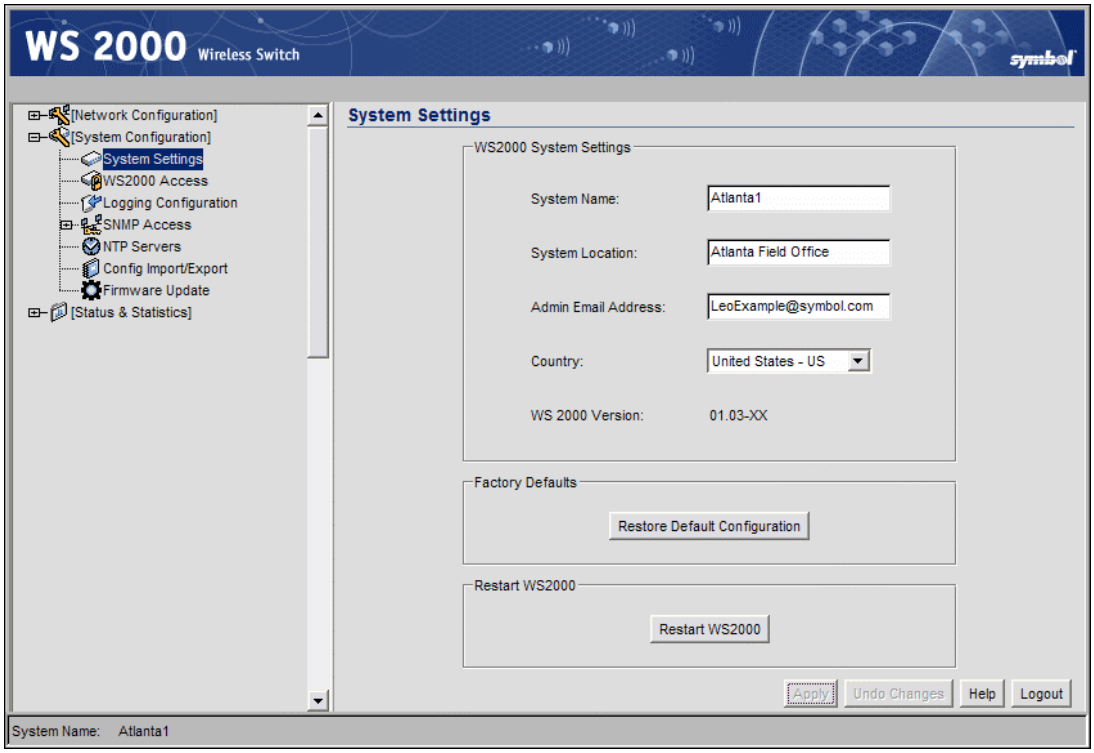
Entering the Basic System Settings

Leo clicks the “+” to the left of **System Configuration** in the left menu, then selects **System Settings** in the left menu.

The system name is used to distinguish between WS 2000 switches for remote configuration. Leo gives the switch a descriptive name, “Atlanta1”. This name will appear in the footer for subsequent configuration windows for the switch. He does not need the descriptive name, but he wants to put in something appropriate in case he needs it later. If the office eventually has more than one wireless switch, the name will help him to know which switch he is working on.

He also enters his email address into the Admin Email Address box. Leo’s corporation uses an SNMP manager that has the capability of monitoring network devices and sending email to the manager of a device that is in an unusual state. This address is the email address that will be supplied to that SNMP manager for this switch.

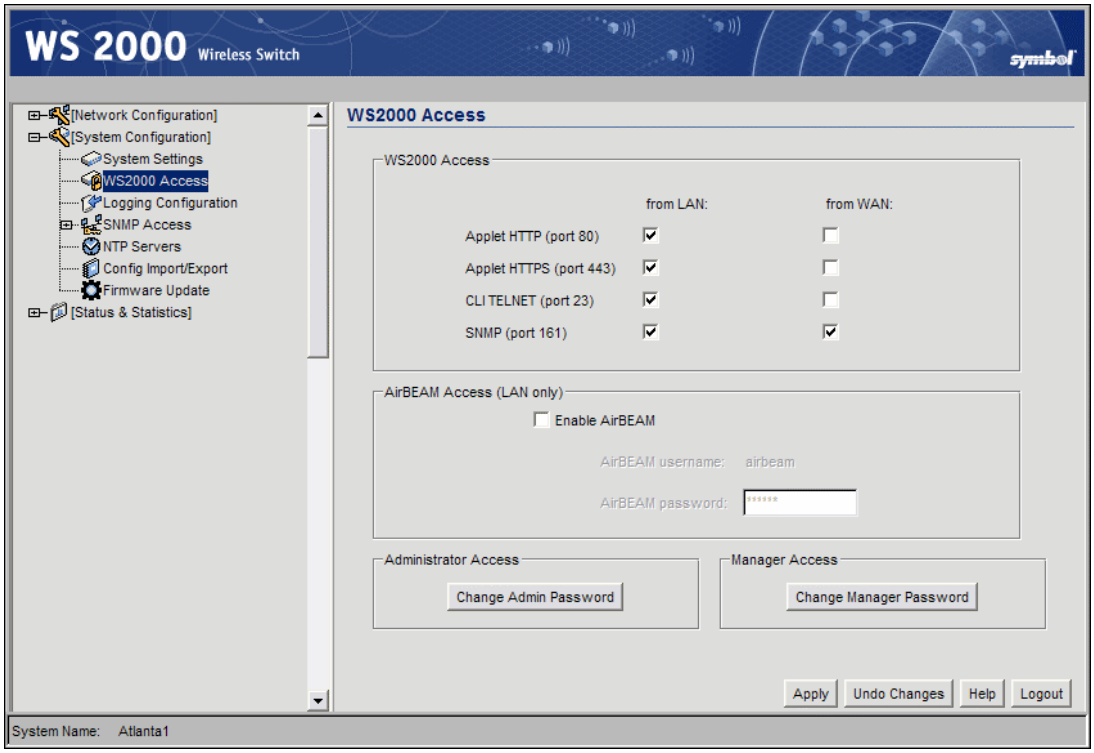
Leo also sets the location to “US”. Different countries have different regulations for the use of these radio frequencies. Setting the location configures the switch to use only the channels, frequencies, and power levels that are legal for that country.



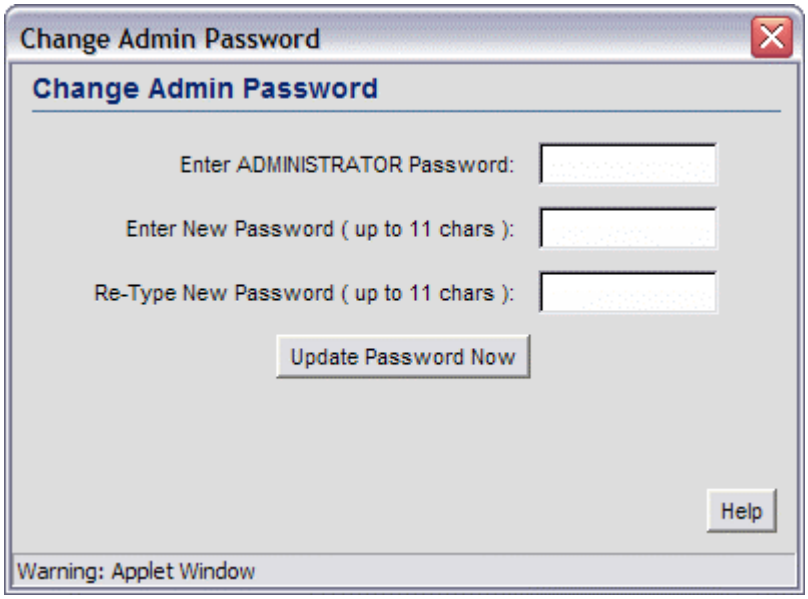
Setting Access Control

Leo then clicks the **WS 2000 Access** node in the left menu. This controls which subnet can be used to reconfigure the WS 2000 switch and how that reconfiguration can be accomplished. Leo will be inside the LAN, so he leaves on all means of reconfiguring from within the LAN. Corporate may want to have read access from outside the LAN, so Leo leaves on SNMP access from the WAN.

AirBEAM is a Symbol Technology product for the management of software on wireless devices. Leo does not have a copy of AirBEAM yet, but he hopes to get one when the company purchases some Voice over IP (VoIP) phones. Until then, however, he turns AirBEAM access off.



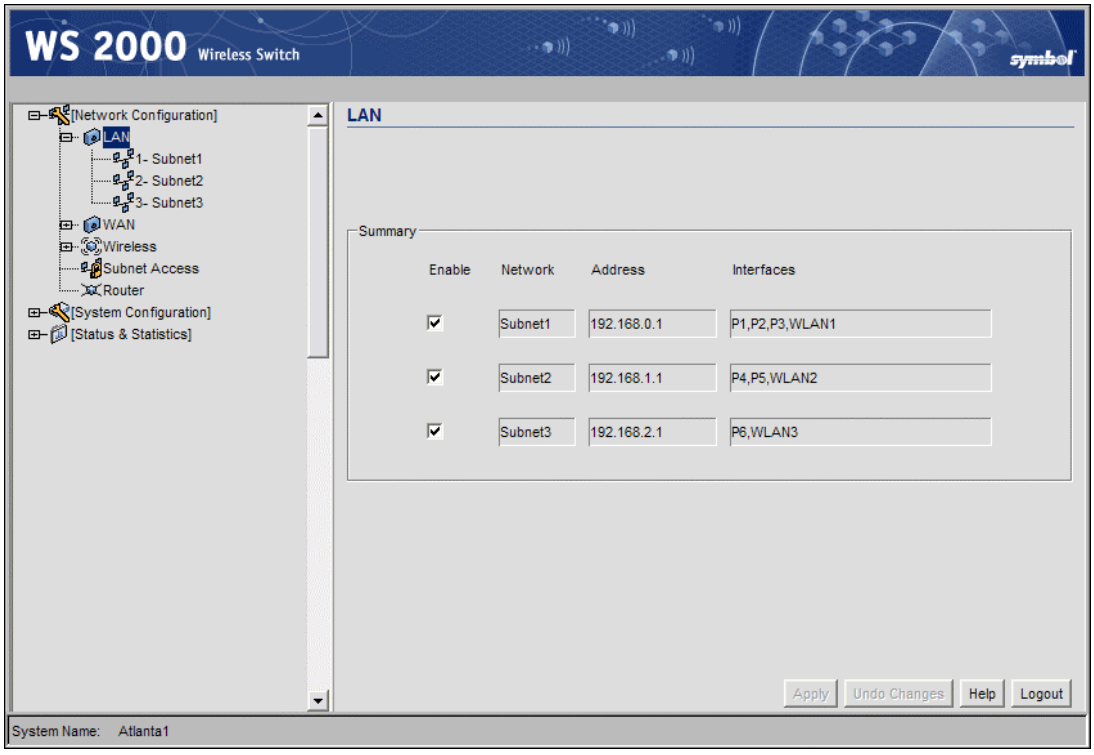
Leo then changes the switch passwords from the default to something relatively secure, something with letters, numbers, and punctuation marks in it.



Leo clicks the **Update Password Now** button to register the password change, then on the **Apply** button in the WS 2000 Access screen to save all changes.

Configuring the LAN

Leo clicks the "+" to the left of Network Configuration in the left menu. It expands and he selects the LAN item.

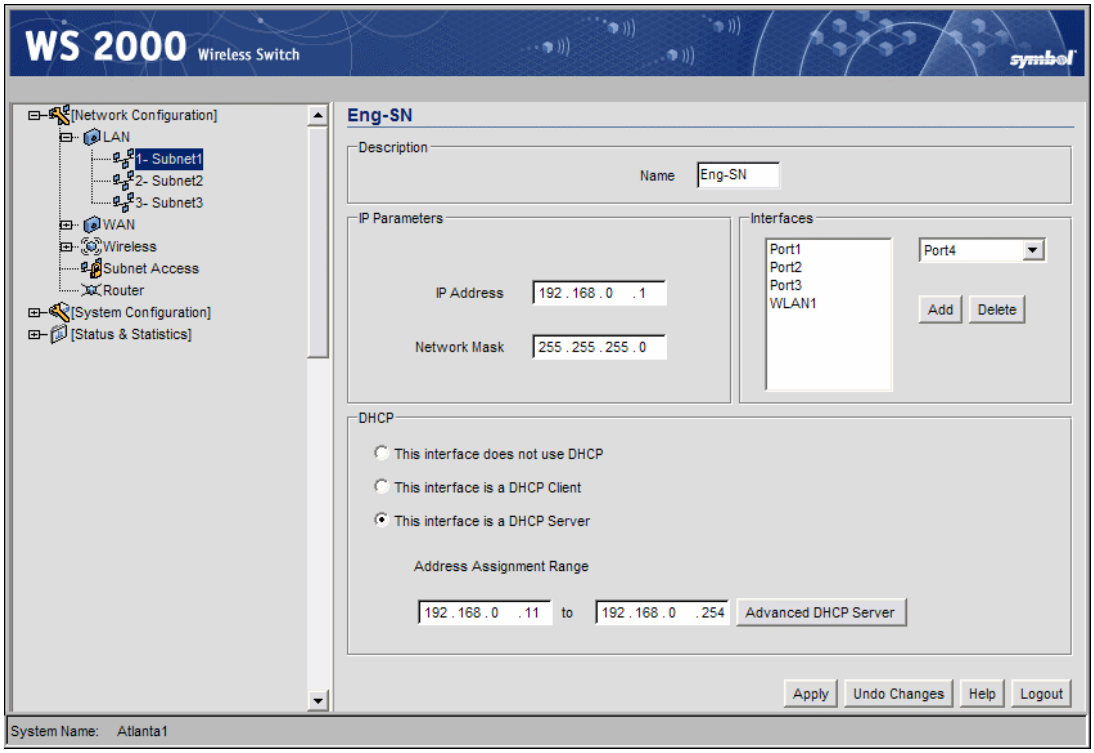


This screen shows the subnets, their IP addresses, and the network interfaces (the 10/100BaseT ports and the WLANs) that are currently associated with each subnet. All of the subnets are enabled; no changes are needed there.

Next Leo needs to configure each of the subnets. He clicks the "+" symbol to the left of LAN in the left menu to expand it.

Configuring the Engineering LAN

Leo selects the first subnet from the choices under the LAN heading. He enters a new name for the subnet, "Eng-SN", to make it easier to recognize this subnet throughout the WS 2000 interface.

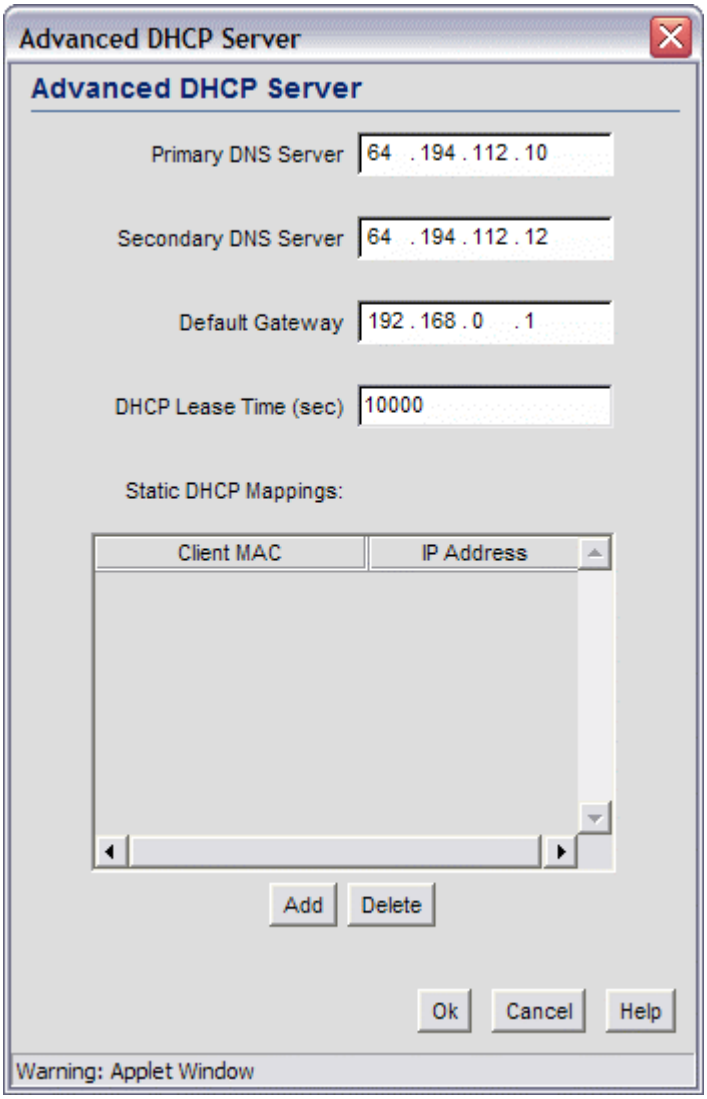


He also selects the option **This interface is a DHCP server**. Choosing this DHCP option means that the switch will pick IP addresses from the **Address Assignment Range** and assign them to network clients on this subnet, as needed.

This screen also sets the IP address for the switch's interface to the subnet. Any address that starts with "192.168" is an internal-use-only IP address. That is, network administrators are free to use these IP addresses anyway they want, as long as the IP addresses are never visible to the outside world. The switch defaults to an address of 192.168.0.1 for the first subnet interface. Leo elects to use the range of IP addresses from 192.168.0.11 to 192.168.0.254 for the DHCP clients in this subnet.

Leo then selects the **Advanced DHCP Server** button. The DNS server IP addresses and the Gateway IP address entered here will be passed down the DHCP clients for this subnet for their own use while associated with this subnet. Leo enters the IP addresses that the corporation's IT department has specified for the corporate primary and secondary DNS servers. For the gateway, Leo enters the IP address for the subnet, the same IP address that he entered for the **IP Address** in the IP Parameters section of the Subnet screen.

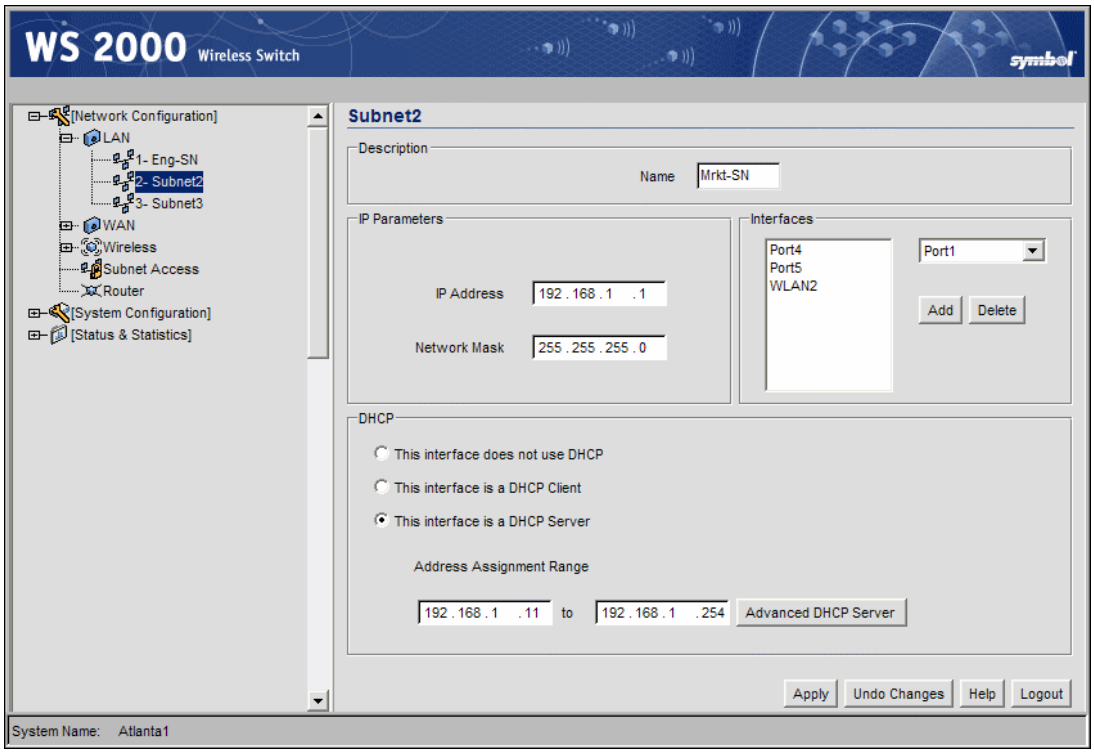
The **DHCP Least Time** field specifies how long a client may keep an IP address when that client is not active on the net. The lease time is currently set for 10000 seconds or a little less than three hours. Leo expects that people using these WLANs will connect for a work day or not. While in the office, he expects that their machines will initiate contact with the network every 10 or 15 minutes for email. When they unplug to go home, this lease time will hold their IP address for another three hours and then return it to the pool for tomorrow. The lease time of somewhere between 10000 seconds and 30000 seconds is appropriate for this application. Leo leaves it at 10000 seconds.



There is no reason to set up static DHCP mappings now. These would permanently lease an IP address to a client with a specific MAC address. Leo clicks the **OK** button on the Advanced DHCP Server window, then the **Apply** button on the subnet window.

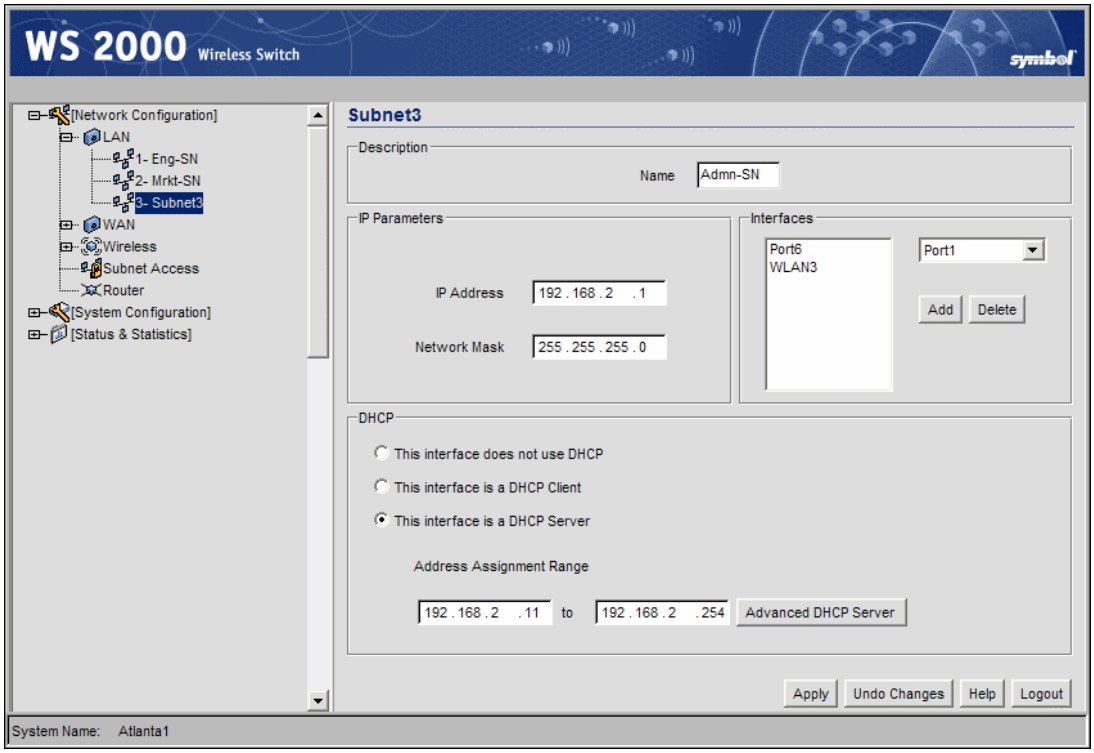
Configuring the Sales Subnet

The sales and marketing subnet is configured exactly the same way as the engineering subnet, though with a different name and a different IP address range.



Leo selects the **Advanced DHCP Server** button and follows the same procedures as he did for the engineering subnet. Leo clicks the **OK** button on the **Advanced DHCP Server** window, then the **Apply** button on the subnet window.

The administration subnet is configured in the same way:



Again, Leo fills out the advanced DHCP screen as he did for the two previous subnets. Leo clicks the **OK** button on the Advanced DHCP Server window, then the **Apply** button on the subnet window.

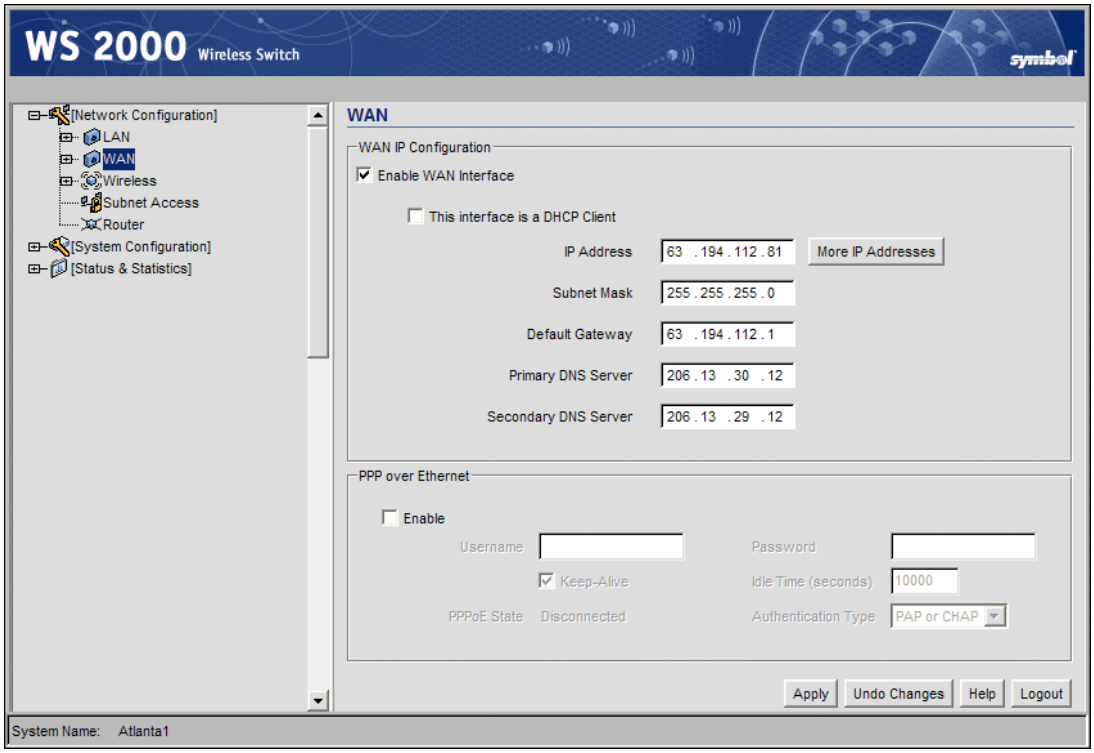
The next step is to configure the WAN interface.

Configuring the WAN

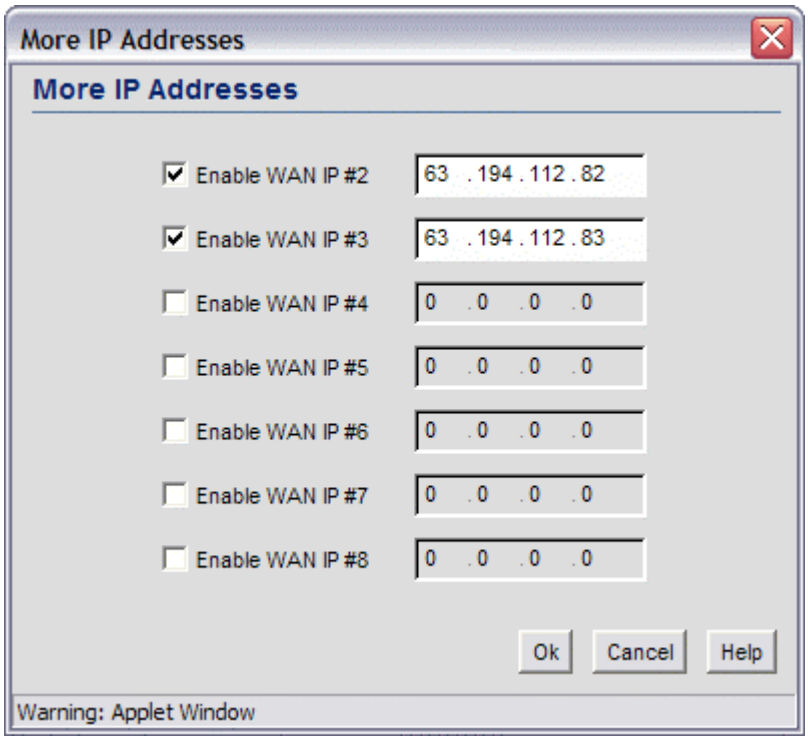
Next Leo configures the WS 2000 WAN interface. This interface connects the WS 2000 switch to the VPN appliance and, through that appliance, to the Internet.

Leo enables the WAN interface, but leaves the DHCP client option disabled. Instead of using DHCP to get address information for the switch, he enters the permanent information that he previously obtained from the corporate network administrator. He enters the IP address for the switch, the gateway address (in this case, the VPN appliance), and the IP addresses of the corporate primary and secondary DNS servers.

The corporation has a frame relay link between this office, the corporate network and the Internet. If the connection to the WAN had been through a DSL link, the account information would be entered in the PPP over Ethernet section on the bottom of this screen. Since it will not be needed, Leo makes sure that **PPP Over Ethernet Enable** checkbox is not checked.



Leo has three addresses for this switch. He plans to use one address for the traffic from each of the subnets. He selects the **More IP Addresses** button and enters the other two IP addresses:

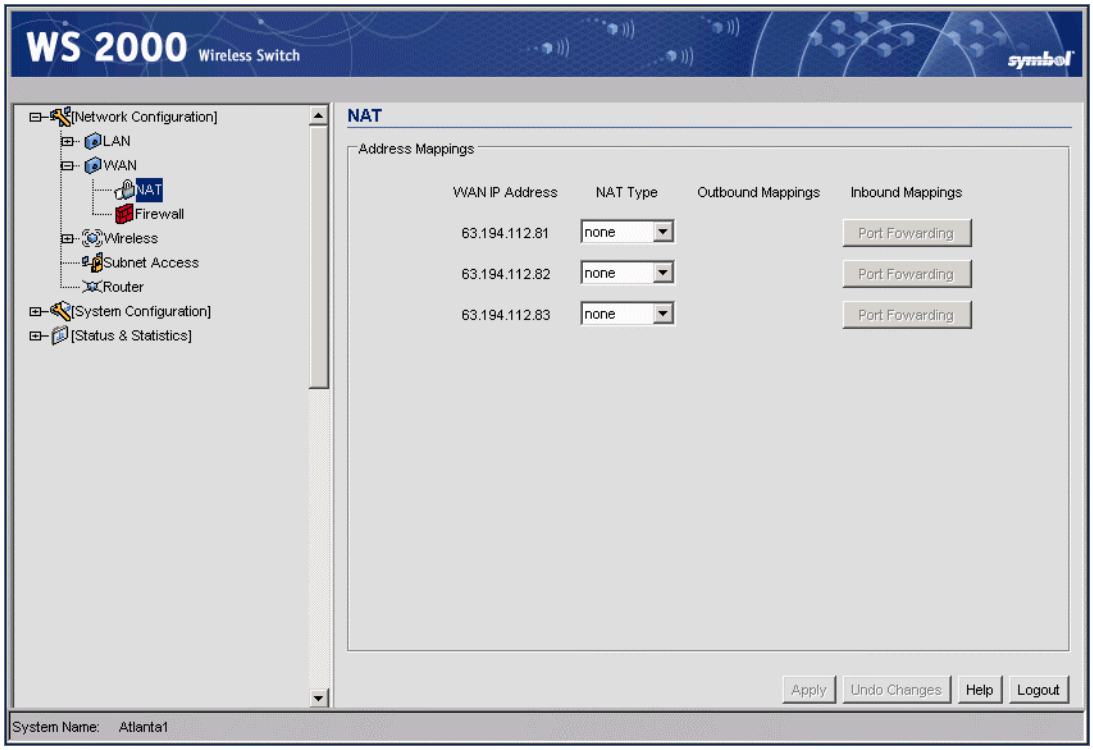


He clicks **Ok** button in the address window, then the **Apply** button on the WAN window to save his changes.

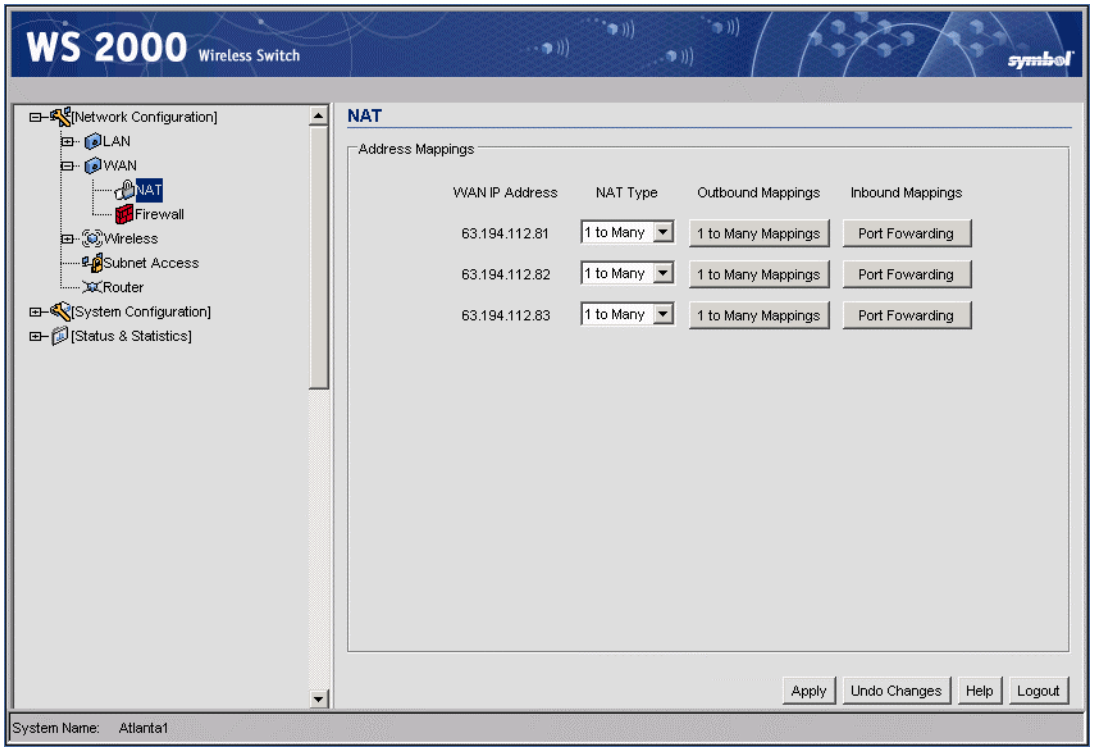
The next step is to set up the network address translations (NAT).

Setting Up Network Address Translation

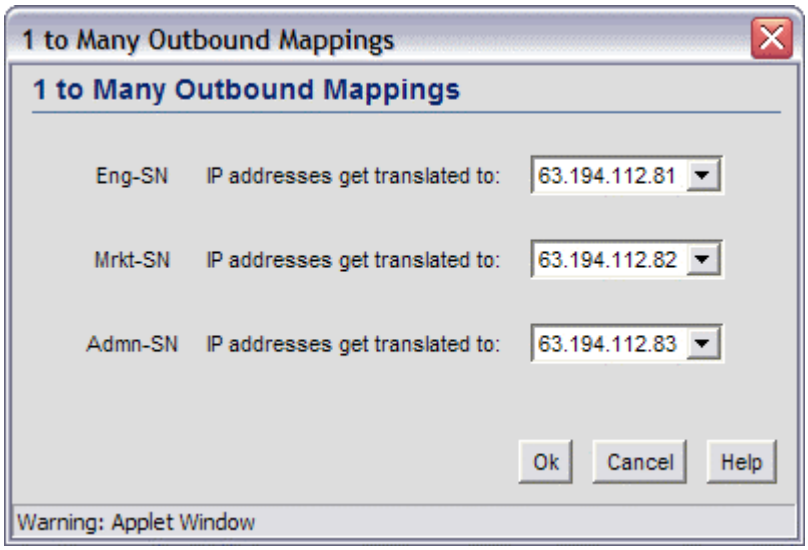
After entering the IP addresses for the WAN interface, Leo clicks the “+” left of the WAN item in the left menu to expand it. He then selects the NAT item. The WS 2000 displays the three IP addresses he entered when configuring the WAN.



Each of these IP addresses will serve as the alias for all of the traffic from its corresponding subnet. It will serve as the only alias for many internal-only IP addresses. Leo chooses **1 to Many** from the pull-down menu to the right of each IP number. As he does so, a **NAT Ranges** button appears to the right of the pull-down menus, in the **Outbound Mappings** column.



Leo clicks any of the **NAT Ranges** button to the right of the IP addresses. The **1 to Many Outbound Mappings** window displays. Leo uses the pull-down menu to set the outbound IP address for each subnet. These are the same as the inbound IP addresses that he specified when he configured the WAN.

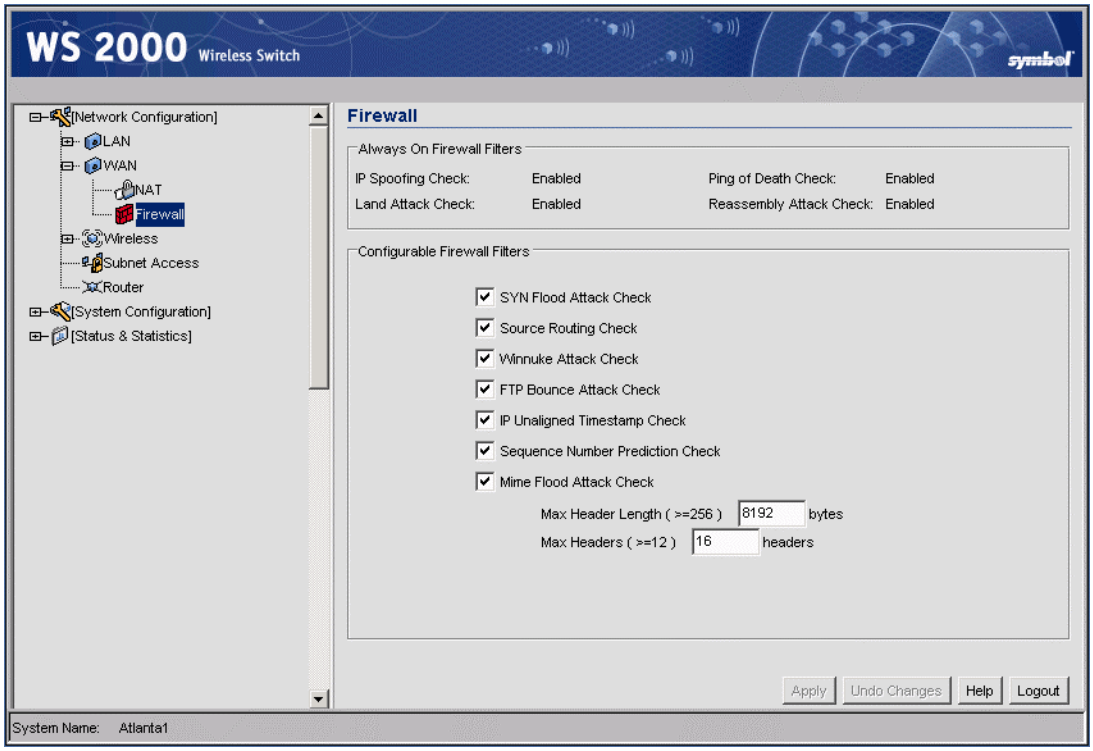


He clicks the **Ok** button to save his entries, and then clicks the **Apply** button in the NAT screen.

The next step is to configure the firewall.

Confirm Firewall Configuration

After setting the NAT ranges, Leo selects **Firewall** under WAN in the left menu. The WS 2000 displays a series of Firewall Filters, all of which are currently enabled.



Leo examines the list and sees no reason to turn off any of the filters. He clicks the **Apply** button.

The next step is to determine which Access Ports each WLAN will use.

Adopting Access Ports

Now that the LAN and WAN interfaces are configured, Leo needs to specify which Access Ports will go with which wireless LANs (WLANs). To do this, Leo needs the MAC address for each Access Port. He removes them from their packaging and finds that they have consecutive MAC addresses: 00:A0:00:00:00:01 through 00:A0:00:00:00:04. He decides that he will install them as follows:

MAC Address	Location	WLAN	Adoption List Label
00:A0:00:00:00:01	Engineering offices	Engineering	WLAN1
00:A0:00:00:00:02	Demonstration room, engineering area	Engineering	WLAN1
00:A0:00:00:00:03	Sales and marketing area	Marketing	WLAN2
00:A0:00:00:00:04	Administration area	Admin.	WLAN3

He marks each Access Port with its intended location and WLAN, so he will not get confused later.

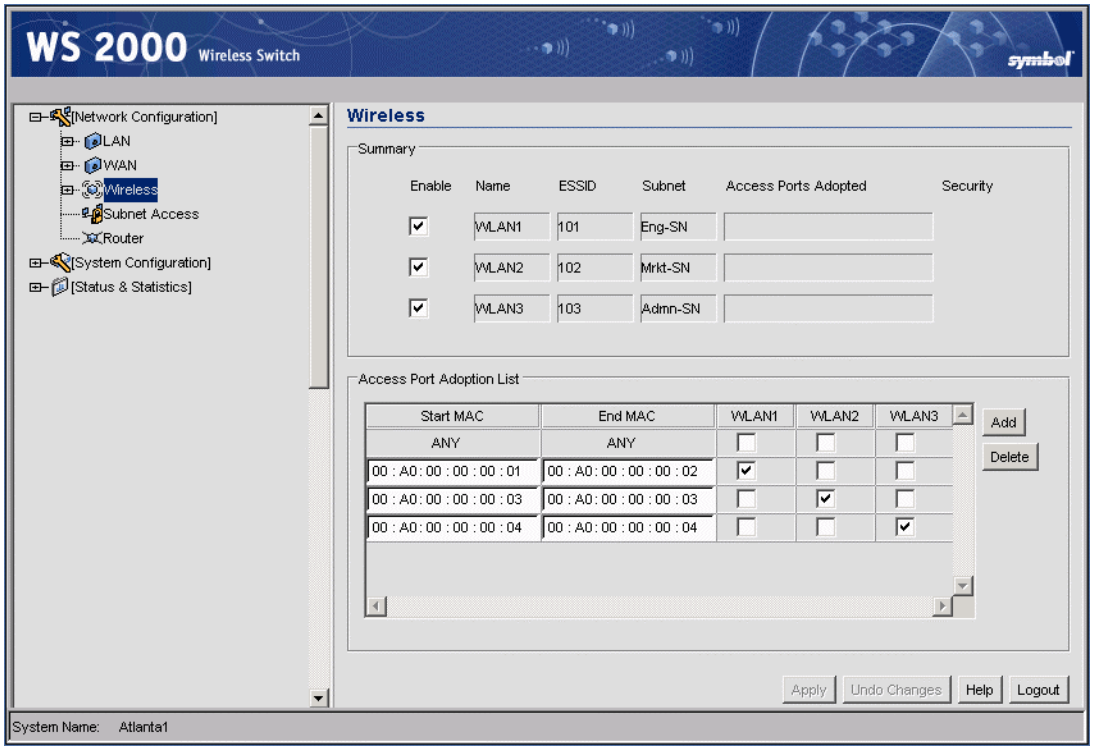
Leo selects the **Wireless** item in the left menu. He sees that all three wireless LANs are enabled, though they do not have the names that Leo wants to use.

He goes to the section labeled **Access Port Adoption List** and deselects the check boxes to the right of the row in which the MAC address range is specified as **ANY**.

For the engineering WLAN, Leo selects the **Add** button, then enters a **Start MAC** value of 00:A0:00:00:00:01 and an **End MAC** value of 00:A0:00:00:00:02. Leo selects the WLAN1 and makes sure that the other WLAN checkboxes are not checked.

To specify the marketing WLAN, Leo clicks again on the **Add** button. In the new line, he enters the same MAC address, 00:A0:00:00:00:03, for both the **Start MAC** and the **End MAC**. Leo selects the WLAN2 checkbox and makes sure that the other WLAN checkboxes are not checked.

Finally, for the administration WLAN, Leo again clicks the **Add** button. He enters 00:A0:00:00:00:04 as both the **Start MAC** and the **End MAC** address. He selects the **WLAN3** checkbox and makes sure that the other WLAN checkboxes for that row are not selected.

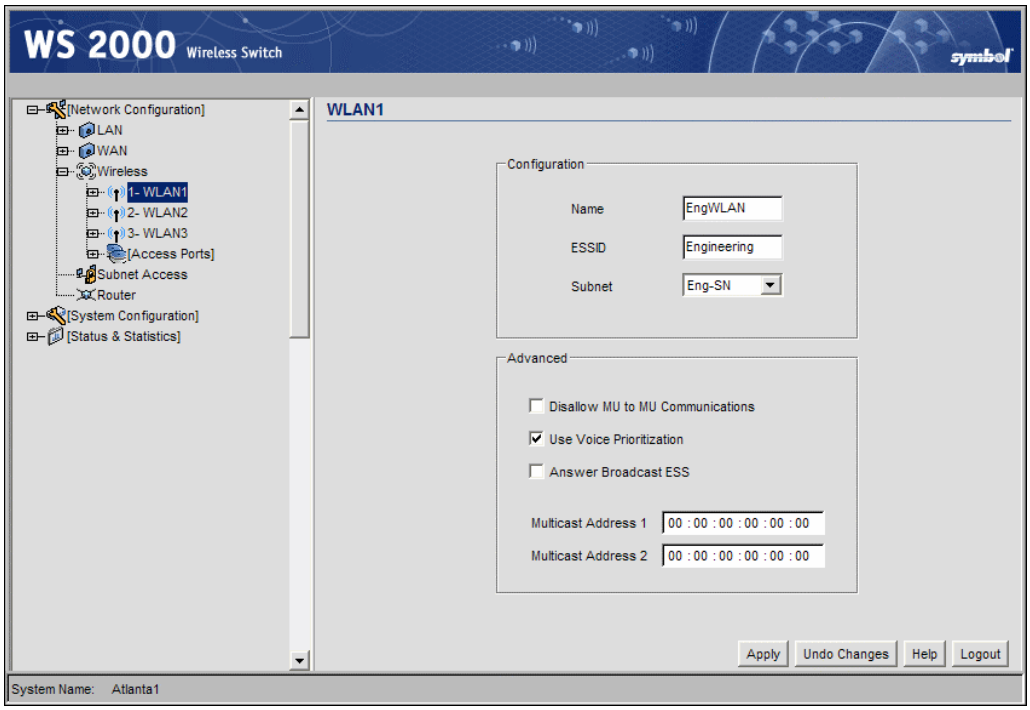


Leo clicks the **Apply** button to save his changes.

The next step is to configure the WLANs.

Configuring the WLANs

Leo has specified which Access Ports go with which wireless LANs (WLANs). Now, he needs to name and configure each WLAN. He expands the **Wireless** node in the left menu, and selects the first WLAN listed.



Leo gives the WLAN the name “EngWLAN” so that subsequent screens in the WS 2000 interface will be a little easier to read. The ESSID is the identification string that his users will see, so he uses a name that will be easy for them to recognize, the string “Engineering.” The interface shows that this WLAN is already part of the Engineering subnet, so there is no reason to change that.

In the Advanced section of the screen, the **Disallow MU to MU Communications** would keep mobile units from communicating directly with each other. Leo believes that people sometimes share files directly, laptop to laptop, instead of using the file server. Leo does not want to prevent this type of communication, so he leaves this option disabled.

The **Use Voice Prioritization** option allows voice over IP (VoIP) devices, such as net phones, to have high priority access to the network. Without high priority access to the network, voice calls can rapidly degrade in quality when the network is busy. Leo does not think anyone is doing VoIP, but he is not sure, so he leaves that option turned on.

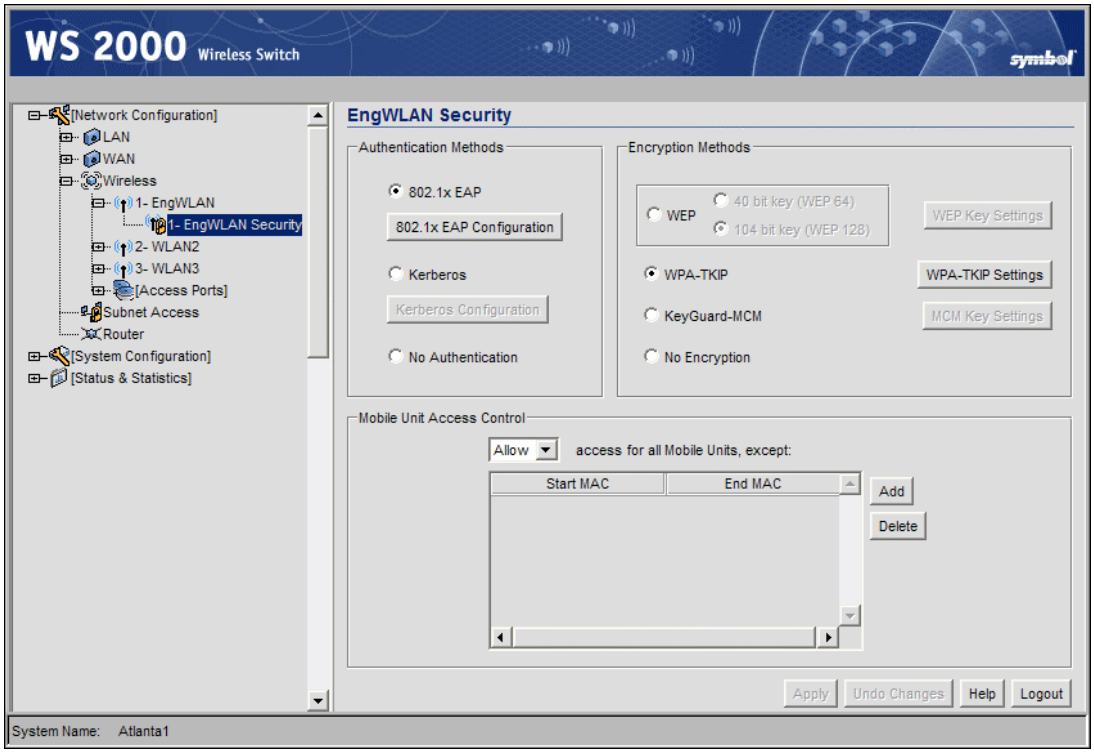
Answer Broadcast ESS instructs the Access Ports on this WLAN to respond to communications from mobile units that do not know what the ESSID for the wireless network is and which are using a default ESSID of “101”. Leo knows that there are no such units in the office; if there were they would not have worked with the previous access point. Leo removes the selection check from the checkbox next to this option.

Multicast Address 1 and **Multicast Address 2** are options included for compatibility with some VoIP phones that use multicast packets. Listing the multicast address allows the voice packets to avoid the usual multicast queue and improves the quality of the VoIP voice traffic. Leo doesn’t have any known need for these, so he leaves the addresses at the default.

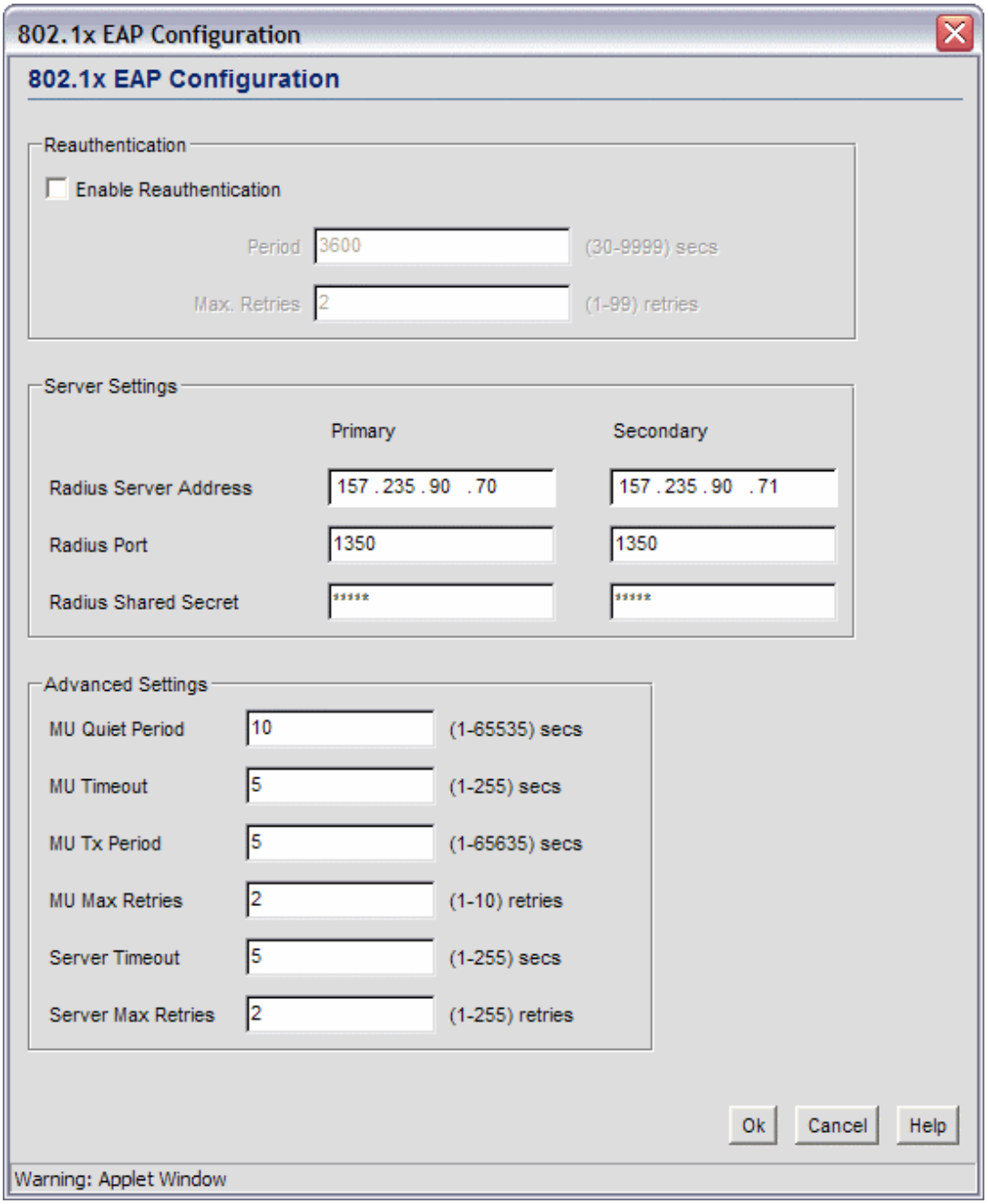
Leo clicks the **Apply** button to save his changes.

Security

The next step is to set security for the engineering WLAN. He selects the "+" to the left of EngWLAN in the left menu to display the EngWLAN Security item. Leo selects that item and the security screen appears. Leo selects 802.1x EAP as the authentication method and WPA-TKIP as the encryption method.



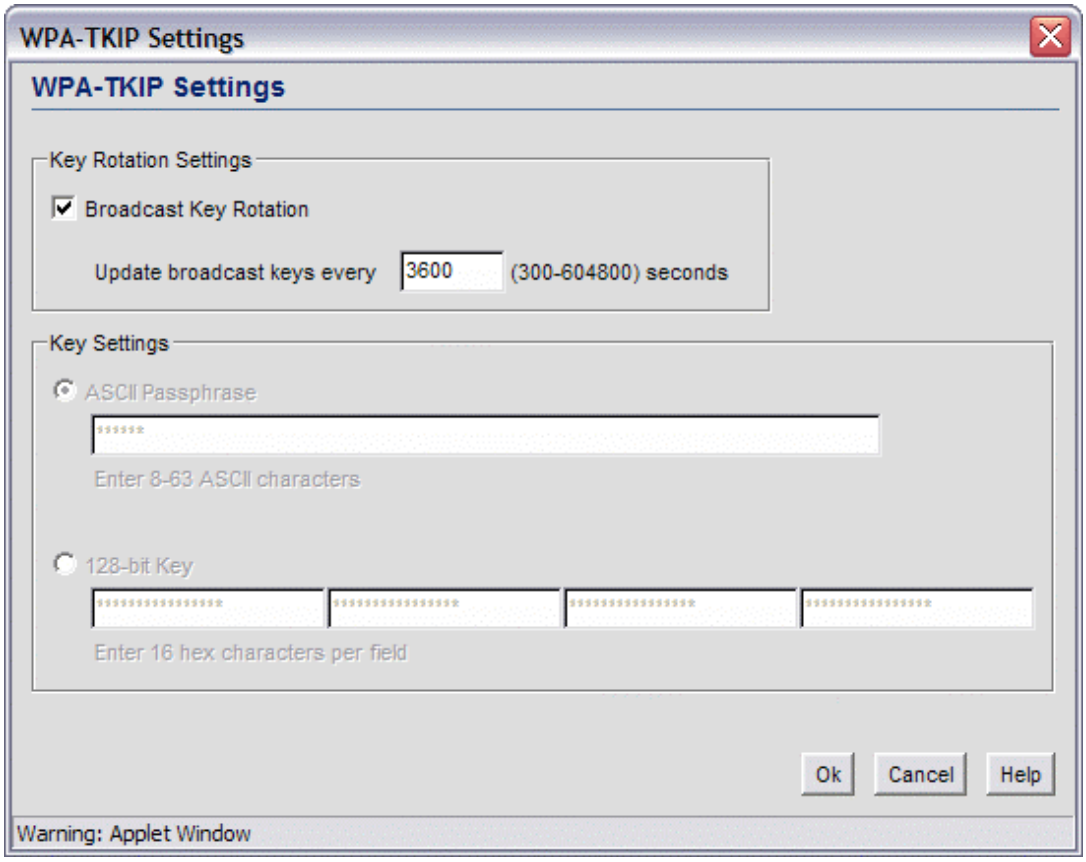
Leo also needs to configure the 802.1x EAP system and the WPA-TKIP encryption. Leo clicks **802.1x EAP Configuration**. In the window that appears, he enters the RADIUS server information that he obtained from corporate system administration: the IP addresses of the RADIUS servers, the ports used for RADIUS communication, and the secret string used to start communication. He leaves the rest of the parameters at their default settings.



Leo clicks the **OK** button to save the 802.1x EAP settings.

Leo then clicks the WPA-TKIP Settings button. WPA-TKIP constantly changes keys, but requires an initial key, known to both ends of the communication. If Leo was not using 802.1X EAP user authentication, that initial key would need to be entered here, in the **Key Settings** section. However, with **802.1x EAP**, the RADIUS server supplies the initial key, so that **Key Settings** section is grayed out for Leo.

Leo does need to set the frequency with which the key for broadcast communication is changed. By default, the WS 2000 changes the broadcast every 600 seconds, every ten minutes. Breaking WEP encryption requires several hours of solid traffic, so Leo decides to change the broadcast key rotation to 3600 seconds, or once an hour.



Leo clicks the **OK** button to save his WPA-TKIP settings, then the **Apply** button to confirm the WLAN configuration.

This completes configuration of the engineering WLAN. The sales and marketing WLAN and the administration WLAN are configured exactly the same way, with the sole exception that they take different names and ESSIDs.

WLAN	WS 2000 Name	ESSID
Sales and Marketing	MrkWLAN	Marketing
Administration	AdmWLAN	Administration

After these WLANs are configured, the next step is to configure the Access Ports.

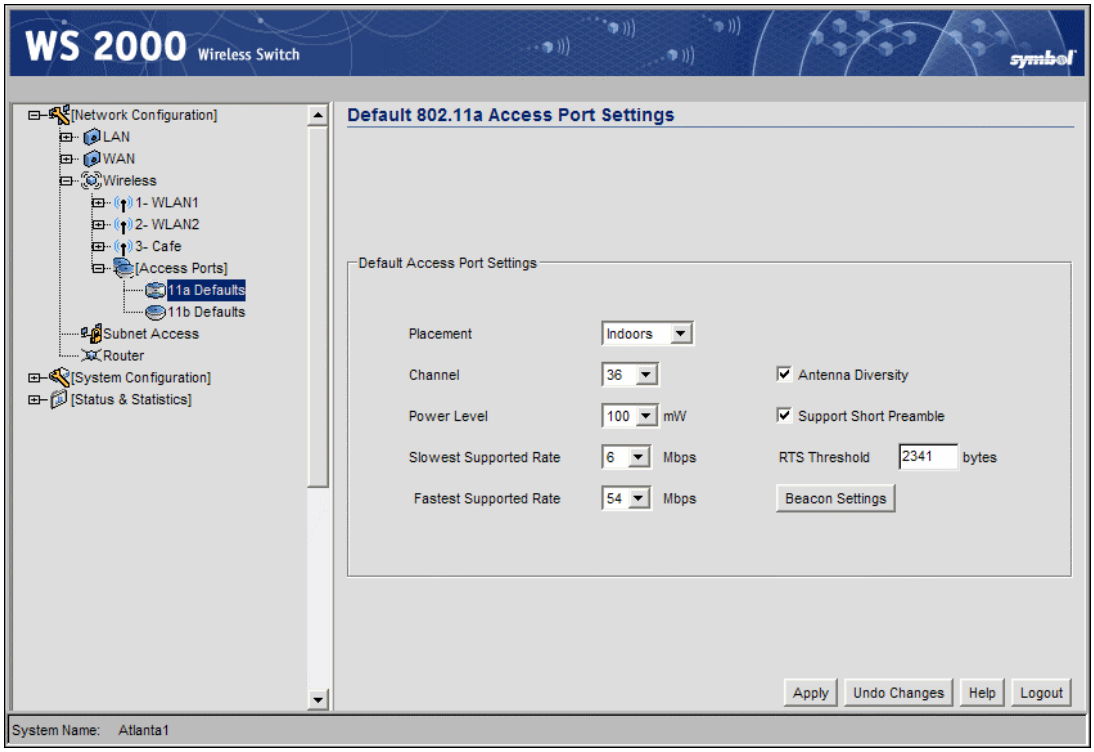
Configuring the Access Ports

The WS 2000 allows the user to specify default settings for Access Ports. Leo expands the Access Ports node in the left menu and selects the 11b Defaults node. Leo has four 802.11a ports, so he will set the default settings for the 802.11a Access Ports.

All of the Access Ports will be indoors, so he specifies **Placement** as Indoors. He sets the default **Channel** as 36, even though all of his Access Ports will be using different 802.11a channels. He sets the **Power Level** to 100mW, the maximum level allowed in the US.

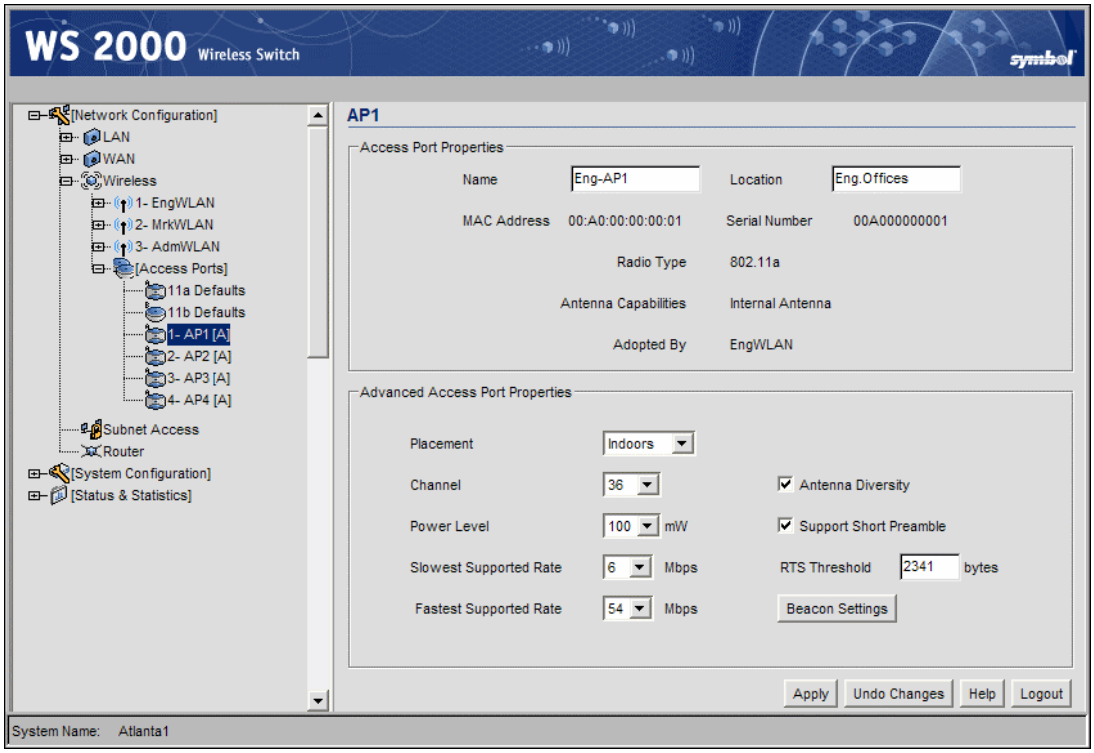
Leo leaves the **Slowest Supported Rate** and the **Fastest Supported Rate** as they are. The switch will operate at the maximum rate allowed by radio conditions, scaling back as needed. He sees no reason to change those parameters.

He does not change the **Antenna Diversity** setting, **Short Preamble** setting, the **RTS Threshold**, or the **Beacon Settings**. These parameters control some of the broadcast mechanics of an 802.11 communication between mobile units and Access Ports. In most cases, there is no reason to change them. He clicks **Apply** to save his choices.



After configuring the default Access Port settings, Leo gets four short 100baseT cables and connects the four Access Ports to the switch. Just to make it easier to remember which port is which, he connects the one with the lowest MAC address to the first port number, the next lowest MAC address to the next port, and so on.

He clicks the “+” to the left of Access Ports in the left menu and selects the menu item labeled “AP1”. The WS 2000 switch has found and queried the Access Port for its MAC address. Leo enters a new name for the Access Port, “Eng-AP1,” and its location, “Eng. Offices."



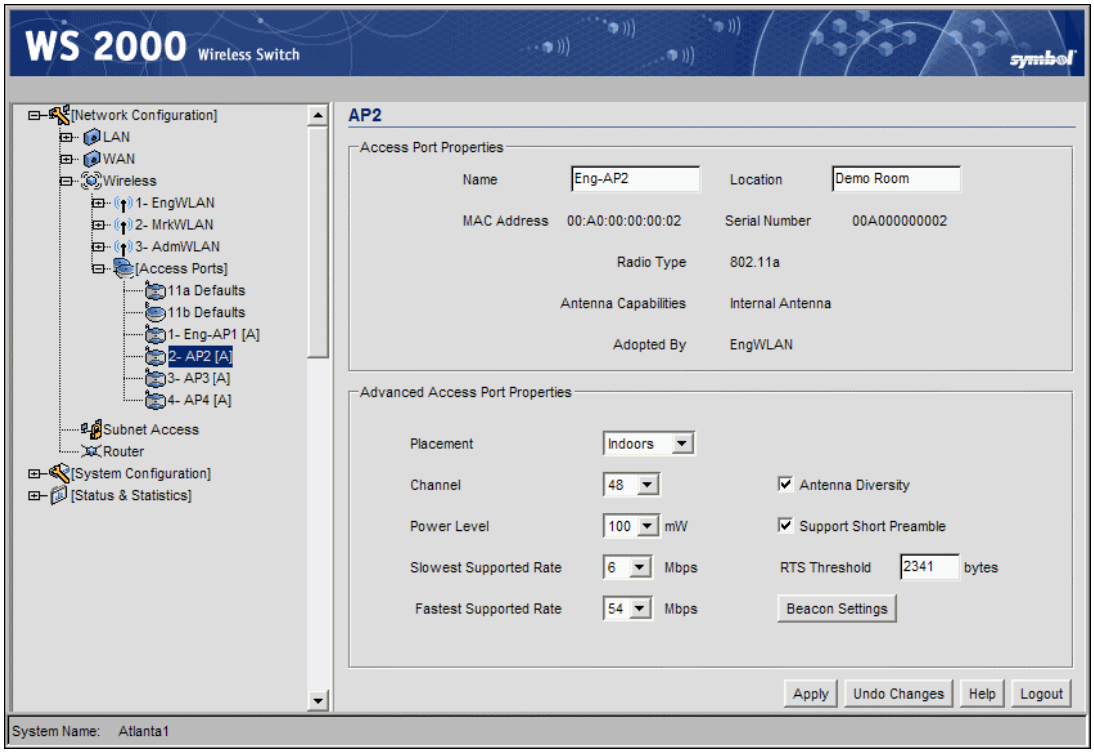
He sets the channel at 36, and notes the number. Access Ports channels should be separated as much as practical to minimize interference between them. The other engineering Access Port will use channel 48 and the marketing Access Port will use channel 60. He then sets the power level at the maximum setting of 100mW.

Leo leaves the **Slowest Supported Rate** and the **Fastest Supported Rate** as they are. The switch will operate at the maximum rate allowed by radio conditions, scaling back as needed. He sees no reason to change those parameters.

He also sees no reason to change the **Antenna Diversity** setting, **Short Preamble** setting, the **RTS Threshold**, or the **Beacon Settings**. These parameters control some of the broadcast mechanics of an 802.11 conversation between mobile units and Access Ports. In most cases, there is no reason to change them.

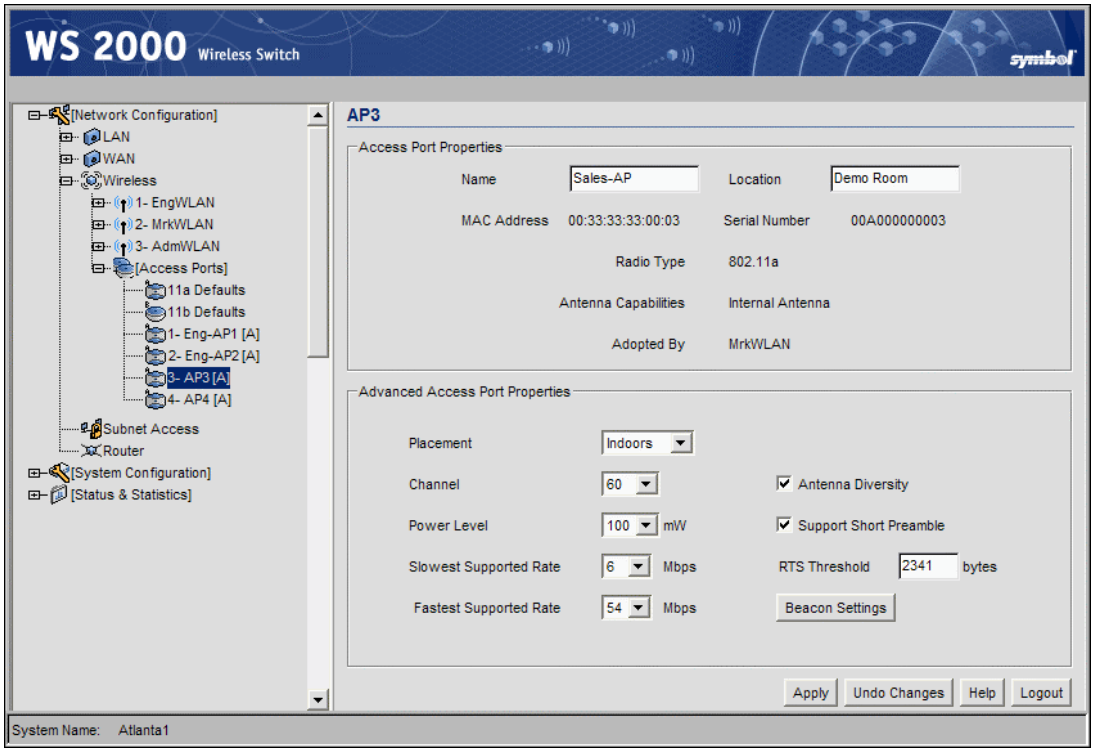
He clicks the **Apply** button to save his changes.

Leo then selects AP2, the second engineering Access Port. He gives it a new name, a location, and assigns it channel 48.



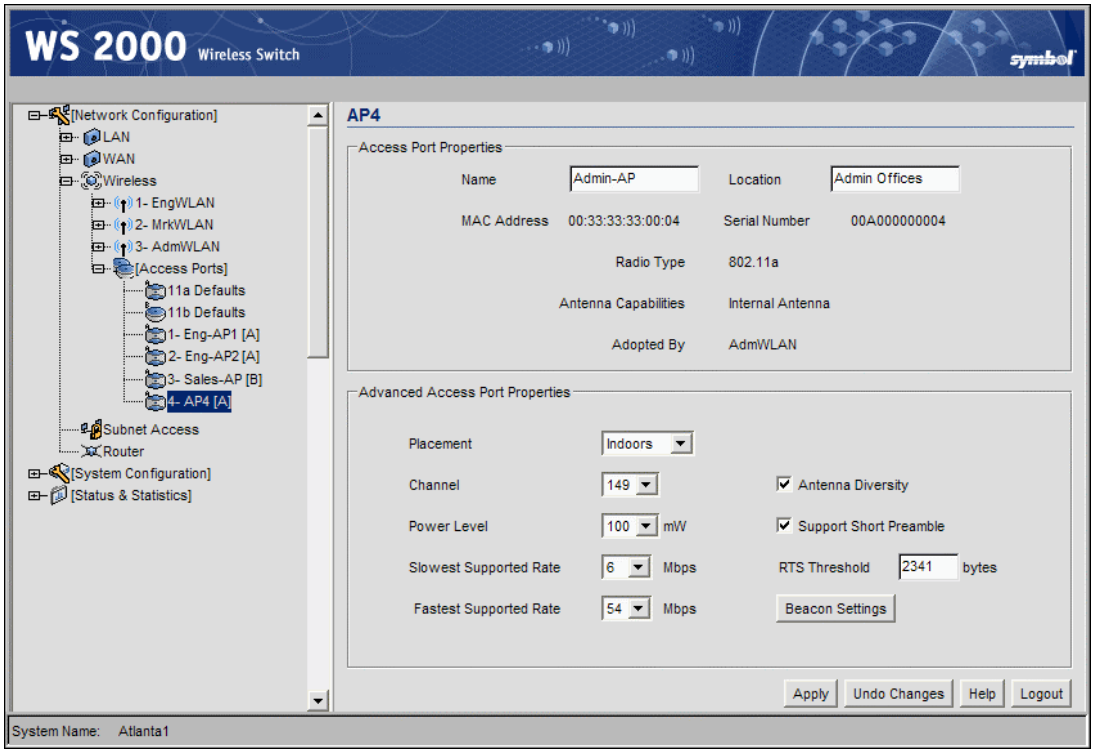
Leo clicks the **Apply** button to save the configuration for this Access Port.

Leo then selects the third Access Port in the left menu. This will be the sales and marketing Access Port. Leo configures it similarly, but uses channel 60.



Leo clicks **Apply** to save his changes.

To avoid interference with the sales and marketing AP, Leo chooses channel 149 for the administration Access Port. He then enters the Access Port name and location.



Leo clicks the **Apply** button to save the changes for the administration Access Port.

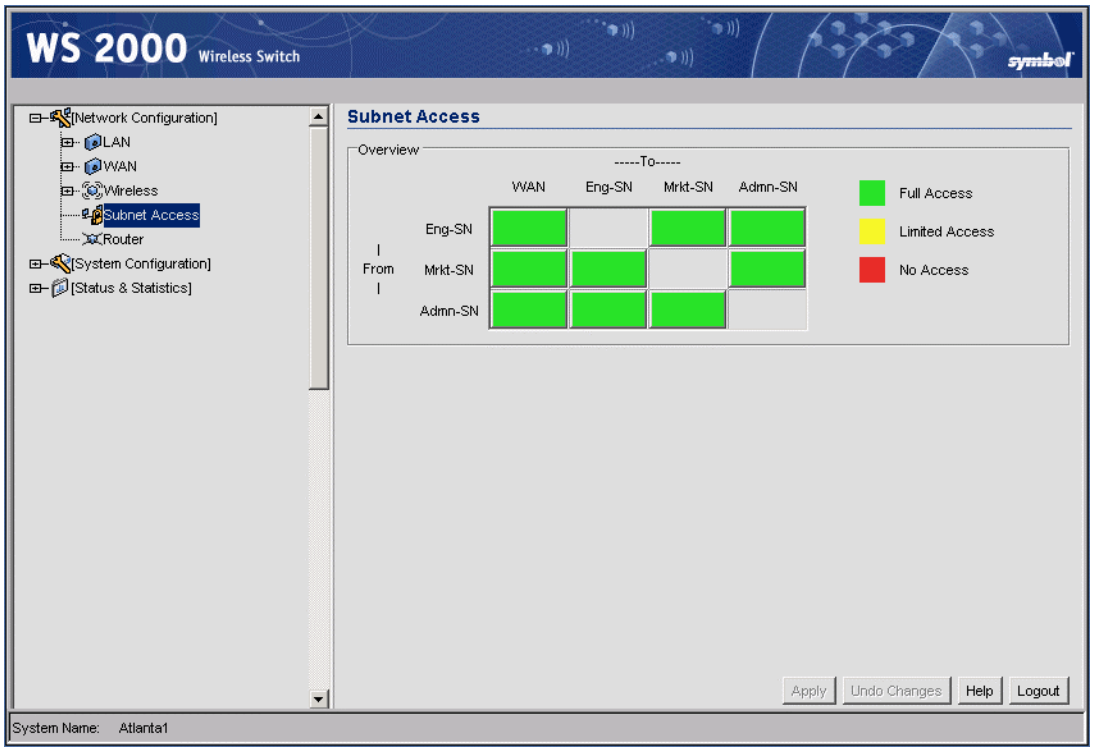
Since all of the Access Ports are 802.11a Access Ports, Leo assigned the channels to minimize cross-channel interference. The channel assignments are listed in the table below:

Access Port	**Channel**
Engineering Offices	36
Demo Room	48
Sales and Marketing	60
Administration	149

The Access Ports are now configured. The next step is to specify access levels between the subnets.

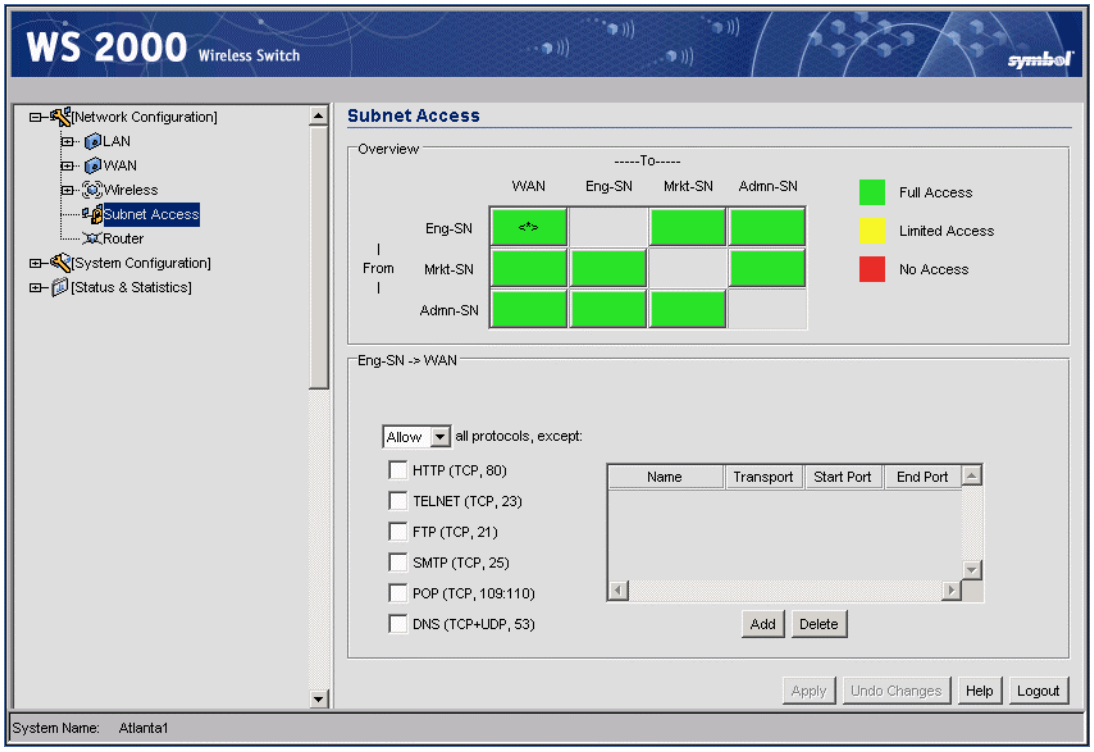
Configuring Subnet Access

Leo selects the **Subnet Access** item in the left menu.



The subnet access defaults to the configuration that Leo prefers. Every subnet has access to every other subnet and access to the WAN. Leo clicks the **Apply** button to confirm this configuration.

If Leo needed to restrict access in some way, he could select an item in the matrix and specify the restriction. For example, if he wanted to restrict access from the engineering subnet to the WAN, he would click on the upper left cell of the matrix:



He could then enter the user-based or protocol-based restrictions in the **EngSN** --> **WAN** section.

Since Leo does not need to make any changes, there is nothing more to be done.

Installing the Access Ports and Testing

The switch is now configured! Leo connects the switch's WAN port to the VPN appliance that goes to the outside world. He gets three laptops and sets each of them to use DHCP for IP address assignment, 802.1x EAP for user authentication, and WPA-TKIP for data encryption over the wireless link. He uses the first laptop to connect to the engineering WLAN, the second to connect to the sales and marketing WLAN, and the third laptop to connect to the administration WLAN. He makes sure that laptops on each WLAN can connect to the WAN and to each other.

After he has tested the three subnets, he installs the Access Ports in their permanent locations. He test coverage with the laptops, making sure each Access Port is covering its assigned area. He also unplugs each of the engineering Access Ports, in turn, to be sure that both are working properly. When everything seems to be working, he sends an email to the users telling them that the new wireless network is up and running!

Appendix A. Sample Configuration File

All of the configuration settings for the WS 2000 Wireless Switch can be saved to a configuration file, and then either imported back into the same switch or transferred to another switch.

Below is a sample configuration file that has been annotated using comment lines. All comment lines begin with // and are blue in color. The configuration file is organized by function area, and most areas correspond directly to a menu item.

```
//
   // WS2000 Configuration Command Script
   // System Firmware Version: 01.09-01
   //
   system
   ws2000

   // WS2000 menu
   set name WS2000
   set loc \0
   set email \0
   set cc us
   set airbeam mode disable
   set airbeam enc-passwd a11e00942773
   set applet lan enable
   set applet wan enable
   set applet slan enable
   set applet swan enable
   set cli lan enable
   set cli wan enable
   set snmp lan enable
   set snmp wan enable
   /
   system
   config

   // Config menu
   set server 192.168.0.10
   set user jhatashi
   set enc-passwd 930f0c9f3c2c
   set file cfg.txt
   set fw file mf.bin
   set fw path \0
   /
   system
   logs

   // Logs menu
   set mode disable
   set level L6
   set ipadr 0.0.0.0
```

```
/
system
ntp

// NTP menu
set mode disable
set server 1 0.0.0.0
set server 2 0.0.0.0
set server 3 0.0.0.0
set port 1 123
set port 2 123
set port 3 123
/

system
snmp
access

// SNMP ACL configuration
delete acl all

// SNMP v1/v2c configuration
delete v1v2c all
add v1v2c public ro 1.3.6.1
add v1v2c private rw 1.3.6.1

// SNMP v3 user definitions
delete v3 all
/
system
snmp
traps

// SNMP trap selection
set cold disable
set cfg disable
set acl disable
set auth disable
set adopt disable
set unadopt disable
set ap-deny disable
set assoc disable
set unassoc disable
set mu-deny disable

// SNMP v1/v2c trap configuration
delete v1v2c all

// SNMP v3 trap configuration
delete v3 all
/
network
wlan
```

```
// WLAN 1 configuration
set mode 1 enable
set ess 1 101
set enc 1 none
set auth 1 none
set wep-mcm index 1 1
set wep-mcm enc-key 1 1 c2767fe55c0a564f90f50a3989
set wep-mcm enc-key 1 2 f2464fd56c3a667fa0c53a09b9
set wep-mcm enc-key 1 3 e2565fc57c2a766fb0d52a19a9
set wep-mcm enc-key 1 4 92262fb50c5a061fc0a55a69d9
set kerb user 1 \0
set kerb enc-passwd 1 8e57
set kerb realm 1 \0
set kerb server 1 1 0.0.0.0
set kerb server 1 2 0.0.0.0
set kerb server 1 3 0.0.0.0
set kerb port 1 1 88
set kerb port 1 2 88
set kerb port 1 3 88
set eap server 1 1 0.0.0.0
set eap server 1 2 0.0.0.0
set eap port 1 1 1812
set eap port 1 2 1812
set eap enc-secret 1 1 8e57
set eap enc-secret 1 2 8e57
set eap reauth mode 1 disable
set eap reauth retry 1 2
set eap reauth period 1 3600
set eap adv mu-quiet 1 10
set eap adv mu-tx 1 5
set eap adv mu-timeout 1 10
set eap adv mu-retry 1 2
set eap adv server-timeout 1 5
set eap adv server-retry 1 2
set tkip type 1 phrase
set tkip enc-phrase 1 a11e00942773343deb84
set tkip enc-key 1
c2767fe55c0a564fa8cd3201b1984a33f986e7872572740a80c6dcff329
05735
set tkip interval 1 86400
set tkip rotate-mode 1 disable
set name 1 WLAN1
set no-mu-mu 1 disable
set vop 1 enable
set adopt 1 allow
set acl 1 allow
set mcast 1 1 01005E000000
set mcast 1 2 09000E000000
delete 1 all

// WLAN 2 configuration
set mode 2 disable
set ess 2 102
```

```
set enc 2 none
set auth 2 none
set wep-mcm index 2 1
set wep-mcm enc-key 2 1 c2767fe55c0a564f90f50a3989
set wep-mcm enc-key 2 2 f2464fd56c3a667fa0c53a09b9
set wep-mcm enc-key 2 3 e2565fc57c2a766fb0d52a19a9
set wep-mcm enc-key 2 4 92262fb50c5a061fc0a55a69d9
set kerb user 2 \0
set kerb enc-passwd 2 8e57
set kerb realm 2 \0
set kerb server 2 1 0.0.0.0
set kerb server 2 2 0.0.0.0
set kerb server 2 3 0.0.0.0
set kerb port 2 1 88
set kerb port 2 2 88
set kerb port 2 3 88
set eap server 2 1 0.0.0.0
set eap server 2 2 0.0.0.0
set eap port 2 1 1812
set eap port 2 2 1812
set eap enc-secret 2 1 8e57
set eap enc-secret 2 2 8e57
set eap reauth mode 2 disable
set eap reauth retry 2 2
set eap reauth period 2 3600
set eap adv mu-quiet 2 10
set eap adv mu-tx 2 5
set eap adv mu-timeout 2 10
set eap adv mu-retry 2 2
set eap adv server-timeout 2 5
set eap adv server-retry 2 2
set tkip type 2 phrase
set tkip enc-phrase 2 a11e00942773343deb84
set tkip enc-key 2
c2767fe55c0a564fa8cd3201b1984a33f986e7872572740a80c6dcff329
05735
set tkip interval 2 86400
set tkip rotate-mode 2 disable
set name 2 WLAN2
set no-mu-mu 2 disable
set vop 2 enable
set adopt 2 allow
set acl 2 allow
set mcast 2 1 01005E000000
set mcast 2 2 09000E000000
delete 2 all

// WLAN 3 configuration
set mode 3 disable
set ess 3 103
set enc 3 none
set auth 3 none
set wep-mcm index 3 1
```

```
set wep-mcm enc-key 3 1 c2767fe55c0a564f90f50a3989
set wep-mcm enc-key 3 2 f2464fd56c3a667fa0c53a09b9
set wep-mcm enc-key 3 3 e2565fc57c2a766fb0d52a19a9
set wep-mcm enc-key 3 4 92262fb50c5a061fc0a55a69d9
set kerb user 3 \0
set kerb enc-passwd 3 8e57
set kerb realm 3 \0
set kerb server 3 1 0.0.0.0
set kerb server 3 2 0.0.0.0
set kerb server 3 3 0.0.0.0
set kerb port 3 1 88
set kerb port 3 2 88
set kerb port 3 3 88
set eap server 3 1 0.0.0.0
set eap server 3 2 0.0.0.0
set eap port 3 1 1812
set eap port 3 2 1812
set eap enc-secret 3 1 8e57
set eap enc-secret 3 2 8e57
set eap reauth mode 3 disable
set eap reauth retry 3 2
set eap reauth period 3 3600
set eap adv mu-quiet 3 10
set eap adv mu-tx 3 5
set eap adv mu-timeout 3 10
set eap adv mu-retry 3 2
set eap adv server-timeout 3 5
set eap adv server-retry 3 2
set tkip type 3 phrase
set tkip enc-phrase 3 a11e00942773343deb84
set tkip enc-key 3
c2767fe55c0a564fa8cd3201b1984a33f986e7872572740a80c6dcff329
05735
set tkip interval 3 86400
set tkip rotate-mode 3 disable
set name 3 WLAN3
set no-mu-mu 3 disable
set vop 3 enable
set adopt 3 allow
set acl 3 allow
set mcast 3 1 01005E000000
set mcast 3 2 09000E000000
delete 3 all
/
network
ap
default

// Default 802.11 A radio configuration
set reg A in/out 149 100
set rate A 6 54
set div A enable
set beacon mode A disable
```

```
set beacon intvl A 100
set rts A 2341
set dtim A 10
set short-pre A enable
set primary A 1

// Default 802.11 B radio configuration
set reg B in/out 1 100
set rate B 1 11
set div B enable
set beacon mode B disable
set beacon intvl B 100
set rts B 2341
set dtim B 10
set short-pre B enable
/

// Access Port configuration
network
ap
delete 1 all
delete 2 all
delete 3 all
/

// LAN configuration
network
lan
set mode 1 enable
set name 1 Subnet1
set ipadr 1 192.168.0.1
set mask 1 255.255.255.0
set mode 2 disable
set name 2 Subnet2
set ipadr 2 192.168.1.1
set mask 2 255.255.255.0
set mode 3 disable
set name 3 Subnet3
set ipadr 3 192.168.2.1
set mask 3 255.255.255.0

// Port To Subnet Map configuration
set port 1 s1
set port 2 s1
set port 3 s1
set port 4 s1
set port 5 s1
set port 6 s1

// WLAN To Subnet Map configuration
set wlan 1 s1
set wlan 2 s2
set wlan 3 s3
```

```
/

// LAN DHCP configuration
network
lan
dhcp
set mode 1 server
set dgw 1 192.168.0.1
set dns 1 1 192.168.0.1
set dns 1 2 192.168.0.1
set lease 1 86400
set range 1 192.168.0.100 192.168.0.254
set mode 2 server
set dgw 2 192.168.1.1
set dns 2 1 192.168.1.1
set dns 2 2 192.168.1.1
set lease 2 86400
set range 2 192.168.1.100 192.168.1.254
set mode 3 server
set dgw 3 192.168.2.1
set dns 3 1 192.168.2.1
set dns 3 2 192.168.2.1
set lease 3 86400
set range 3 192.168.2.100 192.168.2.254
delete 1 all
delete 2 all
delete 3 all
/

// WAN configuration
network
wan
set dhcp enable
set mask 255.255.255.0
set dgw 0.0.0.0
set dns 1 0.0.0.0
set dns 2 0.0.0.0
set pppoe mode disable
set pppoe user \0
set pppoe enc-passwd 8e57
set pppoe idle 600
set pppoe ka disable
set pppoe type pap/chap
set mode 1 enable
set ipadr 1 0.0.0.0
set mode 2 disable
set ipadr 2 0.0.0.0
set mode 3 disable
set ipadr 3 0.0.0.0
set mode 4 disable
set ipadr 4 0.0.0.0
set mode 5 disable
set ipadr 5 0.0.0.0
```

```
set mode 6 disable
set ipadr 6 0.0.0.0
set mode 7 disable
set ipadr 7 0.0.0.0
set mode 8 disable
set ipadr 8 0.0.0.0
/
network
wan
fw

// Firewall configuration
set syn enable
set src  enable
set win enable
set ftp enable
set ip enable
set seq enable
set mime filter enable
set mime len 8192
set mime hdr 16
/
network
wan
nat

// NAT configuration
set type 1 1-to-many
set outb ip 1 0.0.0.0
set inb mode 1 disable
set inb ip 1 0.0.0.0
set type 2 none
set outb ip 2 0.0.0.0
set inb mode 2 disable
set inb ip 2 0.0.0.0
set type 3 none
set outb ip 3 0.0.0.0
set inb mode 3 disable
set inb ip 3 0.0.0.0
set type 4 none
set outb ip 4 0.0.0.0
set inb mode 4 disable
set inb ip 4 0.0.0.0
set type 5 none
set outb ip 5 0.0.0.0
set inb mode 5 disable
set inb ip 5 0.0.0.0
set type 6 none
set outb ip 6 0.0.0.0
set inb mode 6 disable
set inb ip 6 0.0.0.0
set type 7 none
set outb ip 7 0.0.0.0
```

```
set inb mode 7 disable
set inb ip 7 0.0.0.0
set type 8 none
set outb ip 8 0.0.0.0
set inb mode 8 disable
set inb ip 8 0.0.0.0

// Outbound 1-To-Many NAT configuration
set outb map s1 1
set outb map s2 1
set outb map s3 1

// Inbound NAT configuration
delete inb 1 all
delete inb 2 all
delete inb 3 all
delete inb 4 all
delete inb 5 all
delete inb 6 all
delete inb 7 all
delete inb 8 all
/

// Subnet map configuration
network
submap
set default s1 w allow
set default s1 s2 allow
set default s1 s3 allow
set default s2 w allow
set default s2 s1 allow
set default s2 s3 allow
set default s3 w allow
set default s3 s1 allow
set default s3 s2 allow
delete s1 all
delete s2 all
delete s3 all
/

// Router configuration
network
router
set type off
set dir both
set auth none
set enc-passwd 8e57
set id 1 1
set enc-key 1 e2565fc57c2a766fb0d55160d6f92952
set id 2 1
set enc-key 2 e2565fc57c2a766fb0d55160d6f92952
delete all
/
save
```

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